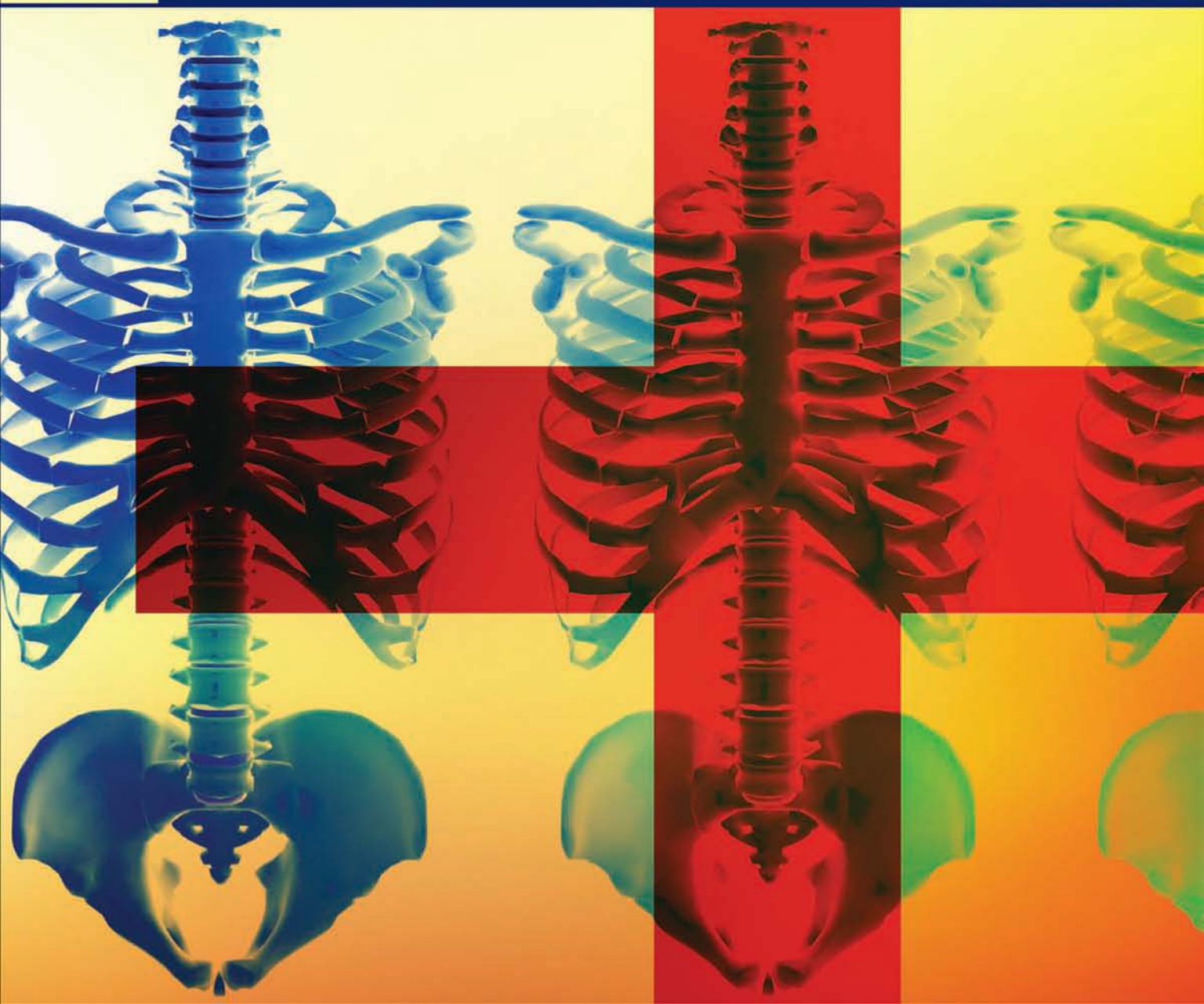
Introduction to

Public Health

for Chiropractors

Michael T. Haneline
William C. Meeker



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This textbook is dedicated to the following chiropractic pioneers in public health: Rand Baird, Herbert Vear, Mitchell Haas, Fred Colley, John Pammer Jr., Karl Kranz, Michael Perillo, Robert Mootz, Michael Loader, Sharon Jaeger, and Lisa Killinger.

Contents

Preface

The primary purpose of this book is to meet the needs of chiropractors, especially chiropractic students, for a succinct, relevant textbook on the application of public health concepts, tools, and behaviors in chiropractic practice. There are many excellent and venerable general textbooks of public health, but we believe this is the first to be written by and specifically for Doctors of Chiropractic.

Public health has many definitions (please see Chapter 1), but in whatever form, D.D. Palmer, the founder of chiropractic, clearly articulated the public health context for the profession late in the 19th century. He identified the source of health problems as originating from "trauma, toxins, and auto-suggestion." These 19th century terms may seem quaint to us now, but external and internal environments are determinants and modifiers of health in human populations and they are as relevant as ever. Indeed, they are becoming even more important in the global context.

As this textbook is being written, the U.S. Congress is grappling with ways to initiate health care system reform to improve the public's health and simultaneously make it more affordable to society. These goals are laudable but extremely complicated to design and implement considering the many powerful competing interests involved in the effort. And yet, there seems to be a growing consensus among all stakeholders that the health care system in the United States needs to refocus its attention and resources toward disease prevention and health promotion, including efforts to instill a greater sense of personal responsibility for one's own health as part of a healthy lifestyle. These concepts have always been a component of a public health professional's approach to the common good, but rarely have they received the support that they should.

The bulk of what constitutes the knowledge base for public health has been part of chiropractic education since the inception of the profession. In recent years, however, the programmatic accrediting body for chiropractic education, the Council on Chiropractic Education, has codified specific learning objectives in its *Standards for Doctor of Chiropractic Programs and Requirements for Institutional Status* under the rubric of "Wellness."[1] As part of the formal accreditation process, chiropractic training institutions must demonstrate that students have the appropriate attitudes, knowledge and skills to appreciate, understand, and implement public health behaviors in the clinical context, especially in the area of health promotion and disease prevention. Doctors of Chiropractic provide about 200 million health care visits in the United States each year. During the course of a typical chiropractic course of care, patients and their chiropractors often

1. The Council on Chiropractic Education. *Standards for Doctor of Chiropractic programs and requirements for institutional status,* Scottsdale, AZ; 2007:46–49.

develop excellent relationships that provide any number of "teachable moments" during one-on-one encounters. We intend for this textbook to contribute significantly to the attainment of these educational goals, and to the implementation of health promotion and disease prevention behaviors in clinical practice.

In addition to the opportunity to contribute to the public's health one patient at a time, chiropractors have many opportunities to become involved in public health activities at the local, community, state, and national levels. There is a small but growing cadre of chiropractors who have become public health activists by participating significantly in the public health community through the American Public Health Association and other organizations. Many have formal education in public health and many have contributed chapters to this book. Over the course of the last few decades, this group has contributed to the growth, development, and professional perception of chiropractic. They should be applauded.

Both of us (coeditors Michael Haneline, DC, MPH, and William Meeker, DC, MPH) pursued graduate degrees in public health early in our chiropractic careers. We believed that the knowledge, skills, intellectual rigor, and sense of community responsibility and activism that are inherent parts of the profession of public health would dovetail nicely with chiropractic. In fact, they have and they do. Both of us have been involved in developing chiropractic research capacity, teaching clinical epidemiology, and contributing original research. Without an understanding of epidemiological principles our efforts would have been much less effective. Both of us have been involved in teaching public health to chiropractic students in a variety of contexts. We know from our own experience and that of our colleagues engaged in similar activities that a good text and reference book would have made our tasks much easier. One of us (Michael Haneline) decided to take matters into his own hands and persuaded the other (William Meeker) to sign on as coeditor, notwithstanding a great deal of soul searching about the difficult reality of textbook creation. And yet, the task has proven to be quite rewarding. What has made this relatively easy is the willingness and the knowledge represented by a wonderful group of contributing authors, each a true expert on the relationship between chiropractic and public health.

The text is organized in a fashion designed to guide the reader step-by-step through public health issues that are applicable to chiropractic practice; from basic definitions to the more complex. Indeed, one of the main objectives of each of the authors as they wrote their chapters was to make their contribution relevant to the practicing chiropractor. Furthermore, chapters were included that are not commonly found in general introductory public health texts, but are of interest to chiropractors, covering topics such as nutrition, occupational and traffic-related injuries, physical fitness, and the integration of chiropractic into the public health system.

Acknowledgments

No book is written without the dedicated support and encouragement of many people. First and foremost we acknowledge the excellent contributions of the many authors who wrote the chapters. Each busy individual accepted an invitation that in essence simply represented a great deal of uncompensated extra work, for which scant thanks are usually extended. Such, is academic life.

We also want to acknowledge the dedicated chiropractors who saw the need to link the field of chiropractic with that of public health and had the foresight and resolve to make it a reality. These individuals are listed in the Dedication section of this book—we commend them and thank them for their efforts.

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CHAPTER 1

CHAPTER OUTLINE

Introduction to Public Health, Public Health Agencies, and the APHA

Rand Baird, DC, MPH, FICA, FICC, and Mitchell Haas, DC, MA*

DEFINITIONS AND DESCRIPTIONS OF PUBLIC HEALTH

This book is designed to be used as a textbook for teaching public health courses to chiropractic students and as a professional reference for doctors of chiropractic during their careers, whether in private practice settings, in teaching and educational administration, or related employment. For these purposes, a common language or lexicon, nomenclature, and terminology to facilitate communication with all the various disciplines involved in public health is essential. And a common definition of "public health" might be ideal.

Public health, however, is a broad and diverse multidimensional field that includes many health-related disciplines. One universally accepted standard definition of public health does not exist. Instead there are many acceptable definitions of public health available from various authoritative sources. And all of the definitions of public health have a precursor in the definition of "health," which according to the World Health Organization (WHO) is: "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity."[1]

Some years ago, the American Public Health Association (APHA) emphasized the following definition of public health: the *application* of medical, social and allied disciplines in an organized *community* activity designed primarily to *protect* and advance the health of the people (*italics* added. The word *application* is used because public health is practical, not just theoretical; *community* is used because

*Contributor to The Special Case of the American Public Health Association on pages 13–17.

the unit of concern and the intervention target is the group or larger community as a whole rather than just the individual patient; and *protect* is included because the focus is on prevention rather than treatment or curative care. More recently, APHA publications seem to prefer the 1988 Institute of Medicine definition for public health: "Public health is what we, as a society, do collectively to assure the conditions in which people can be healthy."[2] The APHA website in 2008 stated: "Public health is a series of individuals, communities, activities and programs working to promote health, to prevent disease, injury and premature death and to ensure conditions in which we all can be safe and healthy."[3]

Some experts have pointed out that public health is a fusion or amalgam of two other disciplines, clinical medicine and epidemiology. There are many other good definitions of public health; each has a somewhat different emphasis, perhaps depending on the background of the definer because public health is so multidisciplinary and includes so many experts from so many diverse areas of expertise. Some emphasize the target for intervention and define public health as community medicine or community health; others emphasize the methodologies and simply define public health as "preventive medicine." Some emphasize the social justice aspect of public health: "what we do as a society to provide an environment for health and to protect those that cannot protect themselves."[4] Many experts define public health as any and all aspects of government's involvement in health, whereas others stress the importance of collaboration, of partnerships formed between government and the private sector. Public health is primary care integrated with community actions. Many public health terms, including the term *public health* itself, are better explained by lists of what is included under the definition rather than by a pure dictionary definition alone, and the categories that help characterize a term are not always completely mutually exclusive. Public health is like a diamond with many facets, and no one facet defines the entirety. A more recent modern trend is to emphasize the health promotion and wellness aspect of public health, with *wellness* being the buzzword of the day.

Still in wide use today, C. E. A. Winslow's classic definition of public health from the 1920s is:

> the science and the art of preventing disease, prolonging life, and promoting physical health and efficiency through organized community efforts for the sanitation of the environment, the control of community infections, the education of the individual in principles of personal hygiene, the organization of medical and nursing services for the early diagnosis and preventive treatment of disease, and the development of the social machinery which will ensure to every individual in the community a standard of living adequate for the maintenance of health.[5]

Mary-Jane Schneider, PhD, in her 2000 book *Introduction to Public Health* claims that public health is ". . . an abstract concept, hard to pin down . . ."[6] and states further that, "Public Health is not easy to define."[7] Likewise, Bernard Turnock, MD, MPH, former director of both the Illinois and Chicago Departments of Public Health, in his 1997 book *Public Health: What It Is and How It Works*, says, "What has become clear to me is that the story of public health is not simple to tell."[8] These comments by noted authorities who work and teach in the public health field are an understatement, and if they cannot define public health, who can? If the definition is, "It is what it is," in the vernacular, "what it is," equates to "what it's all about." And public health is about many, many diverse things. Besides everything else under this broad umbrella called public health, the public health field, the public health profession, and a public health education course are "all about" the following:

- Politics and political questions; public health is both political *per se* and in its context.
- Primary care, and all the multidisciplinary practitioners who provide it.
- The environment, and the lifestyle choices/components of health.
- Hygiene and sanitation.
- Government's roles in protecting the health of the people (e.g., the U.S. Surgeon General and his or her recommendations).
- The contagious, communicable diseases, the reportables, the sexually transmitted diseases (STDs), acquired immune deficiency syndrome (AIDS), and safe sex.
- Wellness, and healthy people in healthy communities.
- Prevention, and prevention, and prevention.

This list illustrates one more reason there are so many acceptable definitions for the term *public health*. An operational definition of public health is *what public health does*. This definition has the added advantage of being able to change as public health needs change over time and place, but also has both the strength and the weakness of being rather all-encompassing.

Whether concerned with learning or teaching public health, unlike certain other medical sciences such as anatomy, which are relatively static, it becomes obvious that public health, like personal health status, is dynamic and ever changing, almost like a study of international and global current events as well as domestic ones.

There are valid general indicators or indices of the health status of a community. Defined in this book's Glossary, *incidence, prevalence, morbidity, mortality*, and *life expectancy* are the most commonly used indices for determining the health status of a community as a whole, and for comparisons among communities or even entire nations. Statistical rates (various proportions expressed per a base, most commonly a base of 1000 people) are calculated, and discussions should include both gross rates and the specific rates that are the pieces of the pie described by the overall gross rates. The failure to include both gross rates and the specific rates that *in toto* compose the gross rates, and a lack of homogeneity among communities or nations being compared, often leads to flawed conclusions, but nonetheless the rates and indices are useful descriptive tools.

The so-called triad or triangle, which in normal balance is called *health* and when out of balance is called *disease*, consists of agent-host-environment. To oversimplify, allopathic medicine concentrates on the agent factors, chiropractic care concentrates on host factors, and public health concentrates on environmental factors. Although the general public often associates health with provision of medical care, public health professionals are equally concerned with the other-than-medical-care determinants of health (overall living conditions, nutrition, degree of environmental sanitation, educational levels, war and peace, lifestyle choices, socioeconomic status, racial and ethnic categories, gender, and other disparities and inequities). Health is typically discussed as an entity, but in reality health is less of an entity and more of a status, an ever-changing, moving target, not static but dynamically changing on a continuum or sliding scale from before birth to death. The level of health care intervention is geared to the level of health need, ranging from prenatal care to postmortem care. Public health decision makers must be cognizant of this continuum and its ranges when formulating health policy.

The scope of public health goes through an ongoing evolution over time and is still changing. Among other things, it includes the traditional contagious communicable diseases; health problems, projects, or programs that affect large population groups having some characteristic in common to form a community of patients; programs funded by government or tax dollars or public funds; noncommunicable health threats having high frequency with resultant high societal costs of morbidity and mortality; the catch-all category of any health need that is being unmet or not even addressed by the private sector, such as medically underserved populations or geographic areas, so that government must step in, almost by default; and any disease or situation that is defined as preventable, or any disease or health situation that by its very nature is preventable or having high potential for *preventability*, and any and all efforts that focus on prevention rather than treatment. Public health is both theoretical and practical, based on strong science and balanced by pragmatic realities.

Hygiene is a term currently more commonly used to refer to personal cleanliness; however, it formerly was used to describe the science of preserving and promoting health in general. The term was often joined or used in conjunction with public health (e.g., public health and hygiene classes). The term *hygiene* can also mean anything that a person or patient does to alleviate their own health issue or prevent its recurrence. In clinical practice, including chiropractic clinical practice, there is a long tradition of recommending individual patient hygiene and simply calling it "patient dos and don'ts." A variation of hygiene, *social hygiene*, is used to describe the hygiene and prevention of disease for groups rather than individual patients.

On a broader level, the term *sanitation* is used to describe control of the environmental risks to health. Although originally used to refer to garbage, filth, or unclean or dirty conditions (i.e., unsanitary), sanitation risks now also include microbial hazards, pathogens, toxins, and over time have come to include physical hazards as health threats in the physical environment. Sanitization refers to the process of efforts to perform sanitation on inanimate objects and surfaces. The phrase *environmental hygiene and sanitation* is still in common use in public health.

Within public health, whether discussing the field of public health, the practice of public health, or formal education programs in public health, it is customary to refer to the various branches, tracks, or areas it encompasses. There are various ways to group or classify these branches. One common list of the branches is:

- Epidemiology
- Biometry and biostatistics
- Environmental health sciences
- Health care services
- Health resources management
- Occupational or industrial medicine
- Population sciences and international health

Other equally good classifications combine health care services with health resources management, or combine epidemiology and biometry, or separate population sciences from international health. But all are ways to group various areas of specialized expertise and knowledge into logical components and a structured conceptual framework.

It is said that public health has a philosophy and a goal (or goals). Its philosophy is to prevent disease by treating the community to provide an environment for health, to

care for the community at large as a whole, to emphasize lifestyle and environmental factors in health, and to take a multidisciplinary team approach to care. And its goal is simply *to prevent*—to prevent by having the greatest possible positive impact on morbidity and mortality within a community, to prevent by doing the most good for the most people while spending the least amount of money, to prevent by providing some basic health care for all people as opposed to a higher level of health care for the select few, to prevent by protecting the health and providing the social justice of care for those who can neither protect themselves or obtain their own, to prevent by providing an environment in which health can occur, and simply to prevent whatever can be prevented.

Public health also has a vision (Healthy People in Healthy Communities) and a mission (To promote health and prevent disease). As mentioned earlier, a unique feature of the public health philosophical approach is that it attempts to prevent disease by treating the community to provide an environment for health. To a public health practitioner, the community is the patient. The unit of study and of concern is not the individual, but rather larger population groups. And the community is increasingly international (i.e., the global community concept).

The public health methodology has several characteristics:

- Recognition of group responsibility
- Reliance on teamwork, interdependence, and multidisciplinary referrals
- Acknowledgment of prevention itself as a major program objective
- Recognition of disease as a multifactorial problem requiring multidisciplinary solutions
- Declaration that health care leading to maximally attainable health is a right of every citizen of every country and of every person on the planet
- Utilization of epidemiology to determine a host of factors and their interrelationships
- Dependence on biostatistical methods
- Education of the public
- Adaptation of programs to local community culture
- Recognition of the agent-host-environment triad, but with emphasis on environment

The public health approach, reiterated by former U.S. Surgeon General David Satcher, MD, PhD, from an earlier Centers for Disease Control and Prevention (CDC) report, involves ". . . defining and measuring the problem, determining the cause or the risk factors for the problem, determining how to prevent or ameliorate the problem, implementing effective intervention strategies on a large scale, and subsequently evaluating the impact."[9] An oversimplification of the public health approach is simply to identify the risk factors and the high risk population groups, and then somehow devise barriers or ways to keep them apart.

Public health originally had four so-called classical functions: (1) control of communicable diseases, (2) provision of health care services including clinics and labs, (3) environmental sanitation, and (4) health education and research. These four have now been condensed and summarized into the three modern core functions of public health: (1) assessment, (2) policy development, and (3) assurance.

In 1990, the Public Health Practice Program Office of the Centers for Disease Control and Prevention published a list of what it termed "The 10 Essential Public Health Services," which are listed in **Table 1-1**.

As a body of knowledge, public health includes some important concepts and many important facts. This book's Glossary lists some key terms and their definitions. To make further reading more comprehensible, the reader is advised to become familiar now with at least the following terms: high risk group(s), and both generic and health hazard–specific subgroups; rates; incidence and prevalence; morbidity and mortality; primary, secondary, and tertiary care; sanitation and sanitization; environment and ecology; hygiene and social hygiene; prophylaxis; gatekeeper; triage; and health promotion.

Chiropractic and Public Health

There is a unique aspect to chiropractic students and chiropractic doctors learning about public health. Every

Table 1-1 The 10 Essential Public Health Services

1. Monitor health status to identify community health problems.
2. Diagnose and investigate health problems and health hazards in the community.
3. Inform, educate, and empower people about health issues.
4. Mobilize community partnerships to identify and solve health problems.
5. Develop policies and plans that support individual and community health efforts.
6. Enforce laws and regulations that protect health and ensure safety.
7. Link people with needed personal health services and ensure the provision of health care when otherwise unavailable.
8. Ensure a competent public health and personal health care workforce.
9. Evaluate effectiveness, accessibility, and quality of personal and population-based health services.
10. Research for new insights and innovative solutions to health problems.

other course in their chiropractic curriculum or postgrad seminars has the goal of preparing them for the one-on-one encounter with each of their respective patients. Only their public health courses or extra training have a different and unique focus: preparing them for their broader role as primary health care providers within the health care delivery system. Although in one sense they are "limited" primary care providers, nonetheless all caregivers have limitations, including those with less restricted licensed scopes of practice.

Likewise, the challenge of teaching public health to chiropractors or chiropractic college students is to take material that is not necessarily intrinsically interesting, and perhaps not even of obvious current or future professional relevance, and to present it in such a way that learning occurs, learning objectives are met, learning is enhanced, and the student becomes motivated and excited about future participation and the integration of chiropractic into mainstream public health activities. A public health class in a chiropractic college is like that in any other institution of higher learning, and the nature of the material is such that many of the topics presented are contemporary international current events. Recognizing the importance and the need for high quality standard education in public health concepts for chiropractic students, Michael Perillo, DC, MPH, and his project participants and collaborators obtained a Health Resources and Services Administration (HRSA) grant for 2000–2002 to research this topic, and constructed *A Model Course for Public Health Education in Chiropractic Colleges*.[10] The Chiropractic Health Care section of the American Public Health Association assembled a task force that provided some suggestions for the content and syllabus for the proposed model course. Several trends in the chiropractic profession in the various areas of public health were noted in this model, including the following:

- Chiropractors already utilize some public health skills in practice, particularly in the area of clinical preventive services.
- There is room for improvement. Enhanced public health training should represent an important tool for the chiropractic health professional to meet 21st-century challenges.
- There is an indication of a small population impact, primarily as complementary to conventional medical care. Impact may be a function of practice functions as well as geographic location. Further assessment of this impact is warranted.
- There appears to be a need and desire for more training in the public health area on the part of students and field chiropractors.
- To help achieve inclusion as a practice characteristic, public health knowledge and skills in chiropractic education should emphasize clinical learning over classroom learning, and be included in various examinations, including the National Board Exam.
- Public health training may have direct implications for the profession's wellness model.[10]

Doctors, including doctors of chiropractic, have certain legal, ethical, and moral responsibilities to public health. These include registering themselves and their practice locations with their local health department (often not done as commonly now as in the past); reporting communicable diseases encountered, whether suspected, known, or diagnosed, even if not treated; educating their patients in hygiene and sanitation as it relates to their condition; observing good personal and environmental hygiene and sanitation in the practice setting; and counseling or teaching patients how to prevent or ameliorate health problems.

PRIMARY, SECONDARY, AND TERTIARY LEVELS OF CARE AND PREVENTION

The Three Levels of Care

Public health is concerned with primary care, secondary care, and tertiary care, and in particular with primary prevention, secondary prevention, and tertiary prevention, whether for acute or chronic conditions. See the Glossary for more comprehensive definitions for the relative terms *primary care*, *secondary care*, and *tertiary care*. In 1976 the National Academy of Sciences reviewed 38 different but acceptable definitions or variations on the theme of primary care. For the sake of introduction, these variations, and those for secondary and tertiary care, can be paraphrased to the following working definitions:

- *Primary care* is office setting–based; is concerned with outpatients who are ambulatory (or in their customary state of ambulation); emphasizes preventions, health promotion, and health maintenance; has a pattern of care that is more general than specialized; is rendered by a physician or provider of first diagnostic or therapeutic encounter or first contact who is considered a portal of entry and referral; deals with more minor health issues or more serious health problems in their earlier stages; and includes basic public health screenings and a degree of comprehensiveness of services either directly or by referral.

- *Secondary care* is hospital setting–based; is concerned with inpatients who have been rendered at least partially nonambulatory by their health problem(s) and are hospital bed-ridden for at least a portion of the day; includes so-called routine surgeries; and is more specialized, intensive, and costly than primary care.
- *Tertiary care* is also hospital setting–based, but is rendered in specially designated areas of general hospitals or at specialty hospitals or major medical centers; uses more advanced techniques, technology, equipment, personnel, staff, and other resources; includes more complicated surgical operations; and is qualitatively and quantitatively more specialized, intensive, and expensive than either primary or secondary care.

Note, however, that an equally good paradigm of defining these levels of care reserves the term *tertiary care* for care rendered in tertiary care facilities such as nursing homes and skilled nursing facilities. Its emphasis is on rehabilitation and restoration, or simply ongoing care, even if in the ambulatory setting, that is continued after a patient is discharged from a hospital or other facility (i.e., tertiary care equals postdischarge care).

Although the focus of this chapter is public health in the United States, mention should be made that other countries have different nomenclature for the divisions of their health care. Using just one example, in England most physicians are either exclusively office-based or exclusively hospital-based, so that becomes the duality of its primary and secondary care.

Chiropractic care is clearly a type of primary care or may even be called limited primary care. In a society that has come to recognize great value in pluralistic and multidisciplinary team approaches, chiropractic adds another dimension of freedom of choice, alternative and complementary methods, and wide applicability. It is likely the specific treatment of choice for many ailments and provides a measure of general palliative relief to many others where it is not the preferred treatment of choice. Chiropractic is most known and recognized for treatment of nonsurgical spinal disorders and neuro-musculo-skeletal conditions, but there is also considerable anecdotal evidence for its usefulness in many visceral or somatic conditions.

Depending on which of the many definitions and how stringent the criteria, chiropractic care would appear to satisfy most of the components of the primary care definition, or at least be in substantial compliance with it—stronger on some elements while weaker on others.

Both proponents and opponents of considering chiropractors as deliverers of primary care might arguably agree that it is not necessary to meet all aspects and components in order to qualify under a definition; rather, most criteria should be met in full or in part to achieve substantial compliance and achieve the objectives of defining a category. An obvious but salient point is that no provider of primary care can be all things to all ill, injured, and needy people. Only a *degree* of comprehensiveness in caregiving is required by most definitions for primary care, with referral to a specialist when indicated being one of the key parts of the primary care definition. Chiropractors already function as gatekeepers and triage points for sorting and acting as portals of referral into the health care system. There is even an old chiropractic adage: "Chiropractic first, medicine second, surgery last," which somewhat parallels primary, secondary, and tertiary care, at least in its consideration of three levels based on severity of illness and intensity of services. There are both traditional and nontraditional primary care providers; in fact, if some groups of nontraditional primary care providers, particularly chiropractors, were offered additional training and formal recognition with defined roles within primary care, then some of the shortage of primary care providers would likely be alleviated.

Chiropractic care is a form of conservative, noninvasive, nondrug, nonsurgical primary care. Chiropractors are primary care providers who use adjustment or manipulation of the spine and other articulations as their preferred treatment of choice, and utilize other forms of manual therapies or so-called "body work" for diagnosis, analysis, treatment, and prevention. Without arguing semantics, specific adjustments to reduce or correct subluxations, general and specific manipulation to improve joint function or relieve nerve pressure, and the other natural and holistic interventions performed by chiropractors have gained widespread public support and ever-increasing scientific community and medical world acceptance as well.

Of course the terms *primary care*, *secondary care*, and *tertiary care* are relative one to another, and not completely mutually exclusive; rather, they are comparative and without sharp demarcations between them, each blending and overlapping into the others. In a more nearly perfect world there would be less need for secondary or tertiary care because primary care would be so much more effective.

For several years one of the biggest compound problems in health care delivery in the United States was physician overspecialization, a shortage of primary care providers, and a geographic maldistribution of providers. Chiropractic doctors had always been a source of primary

care for certain populations, making them a natural component of a solution to this compound problem. In some geographic areas and in some medically underserved areas, chiropractors historically have been the only primary care providers serving a given community. The multidecade shortage of primary care doctors in the United States continues to the current day.[11] This shortage is detrimental and may cause harm to the health of a nation. It is postulated that chiropractic doctors can serve as primary care doctors or even be designated as limited primary care doctors. Certainly it is reasonable that the strengths of any given profession can help alleviate the weaknesses in another area of the overall health care delivery system. It is a very fair contention then when one profession provides a logical and rational, reasonable answer or partial answer to questions, issues, and problems raised by another profession, by government, or by society, it behooves all to collaborate on joint solutions. And although chiropractors are trained as limited primary care providers, much of their training also easily translates into those settings where secondary and tertiary care is rendered. In its *WFC Consultation on the Identity of the Chiropractic Profession*, the World Federation of Chiropractic (WFC) called for a profession-wide embracing of a patient-centered and biopsychosocial approach, emphasizing the mind/body relationship in health, the self-healing powers of the individual, and individual responsibility for health, and encouraging patient independence.[12] Certainly this identity is highly compatible with rendering primary care.

It is clear that the chiropractic profession, chiropractic organizations and institutions, and individual or groups of chiropractic doctors have important roles to fulfill in social and community health. The relationship of chiropractic and chiropractors to public and community health should be no different than that of other health care providers in the community. Chiropractic students and doctors of chiropractic (DCs) need an understanding of public health in order to enhance their communication and credibility with the mainstream public health system so as to maximize their participation for the common good of all.

A few selected examples of health care system problems to which chiropractors offer partial solutions are provided in **Table 1-2**.

The Three Levels of Prevention

The best way to define the three levels of prevention in public health is to describe what is prevented in each. *Primary prevention* is the prevention of the *occurrence* or the *incidence* of illness or injury, prevented by risk reduction in susceptible populations; this is literally prevention of the initial onset of injury or illness. If primary prevention were perfect, society would need no other levels of intervention. But this is an imperfect world,

Table 1-2 Examples of Health Care System Problems to Which Chiropractors Offer Partial Solutions

Problem	Solution
Shortage of primary care providers	Designate doctors of chiropractic (DCs) as primary care providers, who after obtaining additional training can work in areas with plenary physician networks for backup.
Geographic maldistribution of primary care providers	DCs are more likely to respond to incentives to relocate to underserved areas.
High-tech but also often impersonal allopathic care	Chiropractic care and manual therapies are more personal, more hands-on, less mechanized.
Medical care that has become paternalistic and monopolistic, representing only one school of thought (i.e., "Western medicine")	Chiropractic adds another dimension, and works well in partnership with other healing arts such as acupuncture and other Eastern traditions having similar philosophies or approaches.
Overreliance on and overutilization of drugs and surgical procedures	Nondrug, nonsurgical approach to health care.
Nonspecialist MDs are reported as undertrained for diagnosis and treatment of neuro-musculo-skeletal and low back conditions, and especially for nondrug, nonsurgical conservative care alternatives for them.	The training of DCs is geared toward neuro-musculo-skeletal and spinal conditions and focuses on conservative methods.

and primary prevention efforts can do only so much. For those cases too late or too severe by the time they are appropriately noticed, there is secondary prevention. *Secondary prevention* is prevention of disease or injury *progression* (prevention of *severity* or *prevalence* of disease or injury) by early detection and diagnosis and prompt intervention in exposed populations to reduce the extent of the burden on health. Likewise, secondary prevention efforts are imperfect, so a third level termed tertiary prevention is necessary. *Tertiary prevention* is prevention of *permanent disability* or *death* due to illness or injury, by ongoing care and rehabilitation for affected populations, treatment of complications, and restoration of functions. All three levels of prevention—primary, secondary, and tertiary—aim to prevent mortality and varying degrees of morbidity.

The public health care system includes all three levels of prevention but puts the most emphasis on primary prevention. Public health itself can be considered as the foundation or infrastructure base for primary, secondary, and tertiary care. Public health as an industry has had major accomplishments in prevention throughout history. The 20th-century accomplishments were particularly notable in the United States because organized public health initiatives were responsible for great reductions in morbidity and mortality rates and an estimated 25-year increase in life expectancy. **Table 1-3** lists, in random order, the 10 great achievements of the 20th century in American public health according to the CDC, and publicized in *Morbidity and Mortality Weekly Reports* throughout 1999.[13] Selections were based on opportunities for prevention. Directly or indirectly, these achievements greatly benefited the health of every community during the last century and continue on into the new millennium.

Table 1-3 Ten Great Public Health Achievements in the United States, 1900–1999

1. Identifying tobacco as a health hazard
2. Declines in deaths from heart disease and stroke
3. Family planning
4. Fluoridation of drinking water
5. Healthier mothers and babies
6. Immunizations
7. Motor-vehicle safety
8. Control of infectious diseases
9. Safer and healthier foods
10. Workplace safety

AGENCIES: HOW PUBLIC HEALTH SERVICES ARE ORGANIZED AND DELIVERED

A variety of types of agencies are involved in public health. The contributions of each are well-documented in the public health literature, and important for the reader to review. Their classifications are reiterated here and some important examples given, but the reader is referred to more comprehensive sources for more information about the literally hundreds of agencies involved in protecting the public and promoting its health. Remember that many entities that do not consider themselves to be health agencies and are not legally classified as such, nonetheless carry out some roles and functions that can be considered health agency tasks or as an extension or complement of them.

Agencies are how public health services are organized and delivered, an organizational resource. They are a major component of the health care system's infrastructure. The term *infrastructure* is commonly heard in public health discussions. The public health infrastructure is the underlying resources for public health, the support system. Like other public health terms, it is best defined by the components it includes:

- *People:* The human resources, key individuals and teams
- *Agencies:* The organizational resources and structures
- *Data:* The informational technology resources
- *Funding:* The financial resources and money to pay for what is needed

Public health agencies can be classified on a few different bases and characteristics: by levels of function, by sources of funding, by responsibilities, by organizational structure, and by defining characteristics. The major types of public health agencies are:

- Quasi-governmental (a hybrid category)
- Governmental, also known as public
- Nongovernmental, also known as private and abbreviated as NGO (nongovernmental organization)

Each of these will be discussed in the following sections. Although there are private agencies in existence, the term *agency* in the name of an organization most commonly indicates that it is a public sector government agency. On the other hand, the term *association* most frequently indicates a voluntary, private sector, nongovernmental organization.

Quasi-governmental

Although quasi-governmental agencies have some responsibilities assigned by government, they operate more like voluntary agencies. They are funded by combinations of grants, tax dollars, and private sources. They operate relatively independently of government supervision, but have been delegated, or contracted, or just assumed some functions by custom and default that over time became tradition. Perhaps the best example of a quasi-governmental agency at the international level is the International Red Cross, also called the Red Crescent or the Red Crystal in certain countries. It performs various services across borders during emergencies and war. Likewise, the American Red Cross performs duties ranging from war and disaster relief and services to armed forces, to safety-first campaigns, nursing services, blood drives, swimming classes, cardiopulmonary resuscitation (CPR) classes, and AIDS education while coordinating with both the civilian branches of government and the military structure.

Governmental

Government agencies are of course operated and managed by government officials, whether elected or appointed, and by salaried bureaucrats who are their employees. They are funded primarily by tax dollars or assessments and fees imposed on industries that are being inspected and regulated. They have authority for some geographic catchment area or jurisdiction. Whether fairly or not, like other government agencies, health agencies have been criticized as too bureaucratic, too political, poorly coordinated, wasteful, and duplicative.

One parameter on which to classify agencies is by the levels at which they function and the level of government that is responsible for their administration.

- International-level agencies function in two or more different sovereign nations, often in or across several.
- National/federal-level agencies function primarily within one country, although they may have satellite stations in other countries.
- State or multistate regional-level agencies function within one of the U.S. states or in a few adjacent states.
- Local-level agencies function within one city, county, district, or parish, or sometimes in combinations across a few adjacent jurisdictions.

At the international government level is the World Health Organization (WHO) with headquarters in Geneva, Switzerland. The WHO is a branch of the United Nations and has carried out its work since 1948 in six designated regions throughout the world. It is the world's overall directing and coordinating authority on questions involving human health. Historically, the first real international public health agency was called the International Sanitary Bureau, which formed in 1851 to stop an epidemic of Asian cholera that was threatening to become a pandemic; as an ad hoc agency it disbanded after formulating its plan and recommendations. Another international agency is the Pan American Health Organization (PAHO), which is the international public health agency covering the region of the north and south Americas. Originally a free-standing agency, it existed before WHO, making it the oldest international public health agency in continuous existence; however, it now maintains some independence while operating as a branch of the larger WHO.

At the level of national government, all countries have a primary department, agency, bureau, or ministry responsible for the health of their citizens. It may be a cabinet-level agency and either part of some other agency or free-standing within government. The national-or federal-level health agency in the United States is the Department of Health and Human Services (DHHS). It includes the United States Public Health Service (USPHS), which is the principal federal agency concerned with public health in America, and the Centers for Disease Control and Prevention (CDC), which is the USPHS agency responsible for monitoring infectious disease in the United States and around the world in order to prevent disease and promote health. There are many other major and minor governmental agencies carrying out their tasks at the federal level under the overall organizational structure of the Department of Health and Human Services; their roles and functions are thoroughly described in other texts. A list of the various agencies included under the Department of Health and Human Services is maintained at its website, which can be accessed at http://www.hhs.gov.

At the state government–level in the United States, every state has a state health department or board of health that, similar to the national level, may be a free-standing agency or may be a branch or part of some broader agency. The state level in the United States is considered to be the level of sovereign power in health programs and is under the direction of a state health officer appointed by each state's governor. Each has the stated purpose to promote, protect, and maintain the health and welfare of their citizens.

State-level public health agencies are considered responsible for:

- Financing care for the poor and chronically disabled
- Regulating health care costs, including regulating health and other insurances
- Ensuring provider quality, including the licensing and regulation of health care facilities and professionals
- Providing training and setting standards for health professionals and for their training programs
- Authorizing local government health services as needed

Most counties and cities also have a health department or board of health, which is considered at the local level; like those at the state-wide level these may be a free-standing agency or a branch or part of some broader agency. (In Louisiana, the local level of designation is called a parish rather than a county.) Some areas have combined resources and have an agency spanning a wider region, which may consist of several smaller cities or even a few counties. The local level in the United States is the level at which regulation and provision of direct personal health services occurs. This is the "hands-on" level where many public health needs in the various communities are coordinated and regulated.

No matter what the level, each government health agency bears some responsibility for ensuring some aspect of the so-called three core functions of public health (enumerated earlier) to the people of their respective jurisdictions.

Nongovernmental

In addition to agencies operated by government entities, there are also voluntary organizations, also called nongovernmental organizations (NGOs), civil societies, or simply private sector agencies. By virtue of a formalized relationship and official designation, an NGO can be a part of or formally affiliated with a government agency and carry out specific government obligations, often as a condition of the status it holds. These NGOs may operate at any level: international, national, state, or local. They are of many types, including voluntary, professional, social, philanthropic, service, religious, and corporate. They have common defining characteristics, including:

- Created to meet a specific health need or even a single health issue, but can also cover an entire profession
- Usually categorical in purpose
- Have basic stated objectives such as research, education, services, or advocacy
- Funded or self-funded by donations, including from such sources as fundraising events and telethons
- Operated most commonly as nonprofit; occasionally as for profit
- Under their own jurisdiction rather than under direct government control
- Sometimes criticized for a lack of public health expertise and failure to coordinate with government agencies
- Often have high overhead and administrative costs
- Often able to energize a community response by an emotional appeal for their issue of interest rather than the more standard public health approach of starting with a survey of community needs and then prioritizing them for action steps
- Especially effective for start-up programs

Voluntary agencies usually cooperate with government agencies, but sometimes conflict when self-interests or special interests diverge from government plans. The standard public health approach of conducting community needs surveys and inventories; gathering and processing data; identifying trends, patterns, and clusters; ranking priorities; and balancing these against budget constraint realities is sometimes seen by private agencies as too bureaucratic, too much "red tape," too slow moving, and too confining for their liking.

Examples of larger voluntary NGOs include the American Cancer Society, American Heart Association, American Lung Association, Braille Institute, Diabetes Association, and many other fine agencies. NGOs can have various subcategories or classifications as well. Service organizations and social clubs such as the Shriners with their string of children's hospitals, the Elks, the Lions, Rotary International, and many others include health services among the other worthy and charitable causes they support.

Likewise, religious organizations and churches, sometimes referred to as the faith community, can fulfill health roles. Faith-based ministries, notably the Catholic, Protestant, and Jewish congregations, have often included a health care component within their congregations as well as extending into outreach programs. Pastoral care and chaplaincies in hospitals, missionary medicine, and relief programs have operated in both domestic and foreign sectors and incorporate a spiritual or holistic component in their approaches.

Corporate America also has created certain health care facilities that act somewhat as agencies for special target groups of workers. Workplace health and safety promotion; occupational medicine; provision of health insurance; on-site company doctors, nurses, or medical directors; Occupational Safety and Health Administration (OSHA) regulation compliance efforts; and even labor union–negotiated health benefits may qualify as an extension of public health endeavors, despite being carried out by the private sector.

Educational settings play a role in community health as well. The potential of coordinated school health programs for students, teachers, and employees to positively impact community health has been amply described in a text by McKenzie and colleagues.[14] They refer to health education, on-site health services, a healthy school environment, school nutrition, and physical education as key elements that contribute to healthy students. At least in public schools supported by taxes, this appears to be a natural role opportunity. Other aspects of the educational system as part of healthy communities would include campus clinics, infirmaries, and university hospitals and medical centers.

Hospitals, even private hospitals, in a very real sense are a community resource and component of the health care system. In that sense, hospitals also can be considered health agencies, and hospitals work collaboratively with many other health agencies in their common communities. Many hospitals also reach people outside their walls through community outreach programs.

Some communities have a variety of smaller independent clinics or dispensaries, often with services to the surrounding neighborhood provided either free or on an ability-to-pay basis. "Free" clinics may be found in many inner-city areas throughout the United States. Some of these community clinics aim their services at specific target groups, such as women, ethnic minorities, or immigrants. Many have affiliations with full-service hospitals for referral and back-up purposes.

Philanthropic foundations are entities that are formed by wealthy individuals or their corporations to rechannel some of their profits back to community causes; examples include the Bill and Melinda Gates Foundation; Ted Turner's United Nations Foundation; the Carnegie Foundation, which funded and commissioned the famous Flexner Report on early medical education in America; the W.K. Kellogg Foundation; the Ford Foundation; and the Rockefeller Foundation. The Rockefeller Foundation is historically considered the most important for public health in the United States and has been credited with resolving endemic hookworm infestation in the southern states, as well as for funding the implementation of the recommendations of the Flexner Report.

Professional health organizations and associations exist principally to serve the needs of their collective members. They generally have a primary purpose of promoting high standards of professional practice for their specific profession, a concept similar to historical guilds or early trade unions. Most also express somewhere in their charters or mission statements a commitment to improving or safeguarding the people's health. Examples of professional health organizations include the American Medical Association (AMA), the American Nurses Association (ANA), the American Hospital Association (AHA), the American Chiropractic Association (ACA), and the International Chiropractors Association (ICA). The special case of the American Public Health Association (APHA) is treated separately later in this chapter.

The World Federation of Chiropractic (WFC), founded in 1988, is an international federation headquartered in Toronto, Canada. The WFC is an association of national chiropractic associations, an umbrella organization over many independent associations, and has status with the WHO as a formally affiliated NGO. The World Federation of Public Health Associations (WFPHA) provided an official letter of support for the WFC's original application for official relations to the WHO, partly in recognition for chiropractors working within the American Public Health Association for the previous several years. The WFC application was accepted by the WHO in January 1997. As part of its overall mission, the WFC fulfills a public health role by promoting international standardization of chiropractic education, research, practice, legalization, licensing, and codified scope of practice. This commitment to protect the public as well as to further its own profession has demonstrated that the leadership of the profession has concerns broader than their identity and role as the spinal health care experts in the health care system, even while specializing in that role.

Each May the WFC sends a delegation to join the other affiliated organizations and participate in the WHO World Health Assembly meetings in Geneva, Switzerland. After working cooperatively with the WFC over a few years, the WHO published its first *WHO Guidelines on Basic Training and Safety in Chiropractic* in November 2005. The WHO has had a chiropractic researcher from Life Chiropractic College on its staff, and in 2008 it had its first chiropractor serving as a WHO intern.

The WFC established an international Public Health Committee (formerly its "Health for All Committee," so

named to mirror the former WHO objective) under chairman Dr. Rand Baird and charged it with coordinating chiropractic public health programs with WHO initiatives, cabinet-level programs, projects, and priorities. This committee, with its international membership from the seven world regions of the WFC, coordinates a no-smoking and no usage of tobacco products campaign called CAT (Chiropractors Against Tobacco) in support of the WHO Framework Convention on Tobacco Control (FCTC) and its Tobacco Free Initiative. The Public Health Committee carries out charges from the policy level of the WFC Council and Assembly, passing statements on international health issues down to the grassroots level of producing action steps including creating and distributing materials for individual DCs to use in their own offices. Given the importance of tobacco-related morbidity and mortality, and its ranking as the number one preventable health problem in the world, the chiropractic involvement is more than symbolic. The WFC Public Health Committee also promotes efforts in support of the WHO Global Strategy on Diet, Physical Activity, and Health (GSDPAH), with emphasis on reducing the worldwide pandemic of obesity, encouraging exercise, and using postural and movement routines such as the very successful Straighten Up and Move program pioneered by Dr. Ron Kirk of Life Chiropractic College, which has been featured during the annual World Spine Day in October. Because tobacco use, nutrition choices, and physical activity all involve behavior and lifestyle modification, and all can be addressed without the use of drugs or surgery, the natural methods of chiropractic and the position of the chiropractor as a role model, health counselor, and health expert authority figure are clear. Besides World Spine Day, other international public health designated days such as World Health Day, World Environment Day, and World No Tobacco Day each May 31 are observed and promoted through the WFC and other chiropractic organizations.

Besides their actual health endeavors, all of these civil societies and NGOs, public and private alike, publish useful information both for professional audiences and the lay public. The critical significance of all of these civil societies in contributing to the overall public health mission of preventing disease and promoting health is inestimable. Around the world, the importance of coordination, cooperation, partnerships, joint ventures, and combinations of efforts among agencies of all types works to the common benefit, and as a practical issue is the only way to move forward. In fact, partnerships, joint endeavors, alliances, and other cooperative combinations between the public and private sectors and interagency multidisciplinary cooperation are the current and most exciting development in public health.

Chiropractic Within Public Health

Roles for the chiropractic profession and individual chiropractors' involvement in these agencies are an evolving and fairly recent development. In the past few decades, chiropractic has moved from a profession that traditionally practiced outside the mainstream and in relative isolation, to one that actively seeks integration and participation. A sentiment of "me-too-ism" has prevailed as integration increases. Doctors of chiropractic having extra interest, training, expertise, qualifications, dual credentials, and advanced degrees (MPH, DrPH, etc.) have led the way to recognition in various mainstream public health agencies and even in gaining greater visibility in the private sector in nontraditional roles for chiropractors, which in turn has led to greater acceptance in the public sector. Chiropractors have served well in decision making and advisory roles on councils, commissions, and committees, and for the Department of Veterans Affairs, Department of Defense, Department of Health and Human Services, and other health departments and agencies at the international, federal, state, and local government levels.[15] Chiropractors have provided clinical services in projects at Veterans Administration hospitals, and been proposed for commissions in the U.S. Armed Forces and in the uniformed U.S. Public Health Service Corps.

A new cohort of chiropractors holding the combined DC, MPH degrees developed around the new millennium, and some crossovers changed careers or pursued dual careers in public health and chiropractic. Chiropractic had long had some tradition of being a change-of-career profession, and those with a foot in each were naturally positioned to bridge gaps between professions. Even holders of the MD, DC degree combination found that the professional credibility and respect earned in one profession would generalize and carry over to another; the minority phenomenon of chiropractors obtaining hospital privileges, medical staff appointments, and various other affiliations further helped this evolution. These often successful efforts started with volunteerism, and observed track records of performance brought more and higher levels of opportunity to participate in the public health arena.

It is easy to conceptualize and envision DCs serving in salaried posts, as consultants, as members of multidisciplinary teams, and as volunteers within practically all the agencies listed earlier in every category. More

important to the various communities served, there is a need for chiropractic participation and a void without it. Chiropractors bring a unique perspective and approach to complete the health care team. As agencies become more attuned to complementary and alternative medicine (CAM) and concepts of multidisciplinary, integrated care teams, roles for chiropractors will evolve further. Public health has always had a team-care approach, and positions have opened that were originally reserved for so-called "plenary" physicians (MDs and DOs) but eventually also were filled by dentists and veterinarians who developed interests in public health, obtained public health degrees, and assumed their rightful places in public health. So too should DCs move into various roles and positions throughout the public health industry. It is not difficult to project and imagine DCs as federal, state, and local health officers in the United States, and DCs as heads or staffers in international, national, regional, and local health agencies whether governmental, NGO, or quasi-governmental. And in thinking a bit futuristically and out of the proverbial box, it's not out of the question to envision a DC as U.S. Surgeon General. Current developments are opening new opportunities, making for a most exciting future ahead for chiropractic roles and functions within public health.

THE SPECIAL CASE OF THE AMERICAN PUBLIC HEALTH ASSOCIATION

The APHA can best be summarized by Article II of its Bylaws (April 2008):

> The Object of this Association is to protect and promote personal and environmental health. It shall exercise leadership with health professionals and the general public in health policy development and action, with particular focus on the interrelationship between health and the quality of life, on developing a national policy for health care and services and on solving technical problems related to health.[16]

Detailed information about the organization, its many units, and its functions may be found at http://www.apha.org.

Founded in 1872, the APHA is the oldest, largest, most influential, and most diverse organization of public health professionals in the world. It aims to protect all Americans and their communities from preventable, serious health threats. It strives to ensure that community-based health promotion and disease prevention activities, and comprehensive, quality health services are universally accessible in the United States. The APHA represents a broad array of health providers, educators, environmentalists, policy makers, and health officials at all levels working both within and outside governmental organizations and educational institutions. As the oldest (serving the public's health since 1872), largest (55,000+ APHA and state public health association affiliate members), most influential (among the top 15 most effective lobbies on Capitol Hill every year), and most diverse (representing 25 sections of approximately 76 professions in various aspects of public health), there is no other organization comparable to the APHA.

The APHA's multifaceted mission is to improve the public's health, promote the scientific and professional foundation of public health practice and policy, advocate the conditions for a healthy society (particularly advocating in Congress and mobilizing its expertise for federal agencies), emphasize prevention, enhance the ability of its members to promote and protect environmental and community health, and support its affiliate state association members. The APHA paraphrases this mission as to prevent illness and injury, to promote good health practices, to keep the environment clean, healthy, and safe. An APHA slogan is, "APHA: Protect, Prevent, Live Well," and some of its leaders have stated that the abbreviation APHA can also stand for "Advocates for a Public Health Agenda."

Chiropractic participation in the APHA and other public health organizations is essential for true multidisciplinary representation, and is a professional responsibility as well. It affords the profession another opportunity to participate in and help shape the nation's health care agenda. It provides visibility and creates an atmosphere for developing interprofessional collaborations. The APHA is a strong advocate for universal health care, and is thus an avenue for chiropractic to advocate for an "any qualified provider" clause in the U.S. health care insurance system. Many chiropractic colleges have clinics that serve indigent and other underserved populations. Participation in state public health associations and involvement with local health departments can raise awareness of our clinics and ensure that they are included in public health safety networks. The APHA is also an avenue for exploring opportunities by chiropractic for inclusion in integrative care clinics and provider networks.

Structure

The APHA is a complex organization that emphasizes inclusion and diversity. Broadly speaking, members represent two main constituencies: 25 professional sections, of which chiropractic health care is one, and 53 state affiliate

organizations. In addition, the APHA has special interest groups, forums, caucuses, and a student assembly. The APHA is governed by the Governing Council, its legislative branch, and the Executive Board, its executive branch. The organization is supported by a dedicated professional staff led by the executive director. There is a broad range of leadership and service opportunities in the organization. These include association-wide boards and standing committees, as well as task forces and working groups. Each section has its own officers, council, and committees. In addition, section and affiliate leaders have the opportunity to be elected/appointed to the Intersectional Council Steering Committee and to the Committee of Affiliates that represents the association's principal constituencies. The APHA has its own newspaper, *The Nation's Health*; the prestigious *Journal of the American Public Health Association*; and an extensive website that includes substantial public health information, as well as the Chiropractic Health Care section newsletters. The APHA holds an annual convention and is an active supporter of National Public Health Week every April.

The highlight of the year is the 5-day annual meeting and convention every fall attended by as many as 15,000 members and leaders in health and government. Here one can attend thousands of scientific and educational sessions, and national public health and political figures speak at the opening and closing sessions. The Governing Council, Executive Board, sections, boards, councils, and committees all have business meetings at this time. There are endless social events and the exhibit hall is as large as some city shopping malls. The venue provides a golden opportunity to meet public health leaders from numerous universities, all levels of government, and private institutions, all dedicated to improving the health of the public.

Governing Council

The Governing Council consists of about 200 voting representatives from the 25 sections, elected or appointed members from the affiliate state public health associations, and *ex officio* members from the Executive Board. The Governing Council debates and establishes organization policies and resolutions, elects officers, guides the Executive Board, and receives reports from the association leadership.

Executive Board

The Executive Board consists of the association officers, elected members, and *ex officio* members from APHA boards and the Intersectional Council, Committee on Affiliates, and Student Assembly. The Executive Board carries out the policy of the Governing Council, hires the executive director, oversees the administration of the association, appoints committee and board memberships, and serves as trustee of the association's assets.

Sections

Currently there are 25 sections with diverse professional missions. These range from Chiropractic Health Care, Vision Care, and Podiatric Health to Medical Care, Oral Health, and Public Health Nursing, to Statistics and Epidemiology, to Health Administration, and a variety of others. Each section has a chair, chair-elect, immediate past chair, and secretary. Each elects a section council and at least two governing councilors. The section appoints an Action Board representative and representation to the Membership and Program committees. Section budgets are allocated based on membership. The three chairs sit on the Intersectional Council. As an example of the structure of one of the sections, the Chiropractic Health Care section has the following internal committees: Awards, Communications, Membership, Nominations, Program, Resolutions, and Section Manual. The section conducts a scientific program of paper sessions and has had an award-winning exhibit booth at the APHA annual meeting. It also has several business meetings at this time, as well as a midyear meeting held during the annual Association of Chiropractic Colleges conference.

State Affiliates

The 52 state public health associations and the Washington, DC, association fall under the category of state affiliates. These are independent incorporated organizations having a contractual relationship with the APHA. Each has a representative to the Governing Council, called the Affiliate Representative to the Governing Council (ARGC). The relationship between the states and the APHA is important because it allows a coordinated effort to be made on health policy issues of both national and local significance.

Intersectional Council and Committee on Affiliates

The Intersectional Council is composed of all section chairs, chairs-elect, immediate past chairs, and a steering committee. The Chiropractic Health Care section leadership thus has the opportunity to formally interact with the

leadership of all professional sections. The function of the Intersectional Council is to represent the common interests of the 25 sections. The Committee on Affiliates (CoA) is composed of an affiliate governing councilor from each of the 10 DHHS regions, officers, Action Board members, and Executive Board appointees. Its function is to help strengthen APHA/affiliate relationships and operations.

Boards and Committees

The APHA has an Action, Education, Science, Editorial, and Publications Board. Of particular importance, all sections have a representative on the Action Board and are thus involved in planning and organizing APHA policy implementation; this includes APHA's legislative program. Standing committees include Bylaws, Equal Health Opportunity, Membership, Women's Rights, and Policy. There is also a program committee that includes a member of each section.

APHA Staff

The APHA provides extensive services to its members and organizational units. Staff is also responsible for organizational operations and policy implementation. The executive director oversees the following departments: Convention Services, Government Relations and Affiliate Affairs, Membership Services, Publication Services, Media Relations, Scientific and Professional Affairs, Learning and Professional Development, and Section Affairs.

What is the purpose of DCs' public health involvement through APHA participation? Simply stated, it is the right thing to do! Chiropractic is a holistic health care discipline. As such, it has an obligation to address the patient's social and physical environments, both on the personal level and in the community domain. Community health is the domain and purview of public health and is hence a natural fit for chiropractic participation. The APHA is *the* public health organization for chiropractic participation.

History of Chiropractic in the APHA

Public health has a long and glorious history, probably dating from prerecorded times; its written history goes back thousands of years from perhaps before 2000 B.C., all the way forward to modern days. This history is important to study but well-documented in other texts, and need not be repeated here. However, the history of chiropractic in public health in the United States, and in particular the history of chiropractic involvement in the APHA as part of its integration into mainstream public health activities, began in the late 1970s. Just as the chiropractic profession and individual chiropractors have had a history and roles in public health, so does chiropractic and chiropractors have an important history and roles within the APHA. The APHA has been and continues to be an important vehicle for integration into mainstream public health activities. Over the years both the ACA and ICA have passed various policies and resolutions dealing with public health, not the least of which is the public's right to choose chiropractic care as part of its quest for health. Professional involvement in public health has served the public interest by enhancing chiropractic communication and credibility. In 1983 the Governing Council of the APHA passed its Policy #8331, *The Appropriate Role of Chiropractic in Patient Care*, recognizing ". . . spinal manipulation by chiropractors [as] safe and effective [for] certain disorders of the neuro-musculo-skeletal system, particularly low back pain."[17]

In 1995 the Chiropractic Health Care section was established within the APHA, giving chiropractic the equity and parity with all other health care professions that it had sought. The section's name was very deliberately chosen by its leadership in order to be the only one of APHAs many sections to have both the terms *Health* and *Care* in its official name. The formal section application document of the former Chiropractic Forum special interest group within the APHA was written by a team consisting of six of the most highly regarded and acknowledged experts in the area of chiropractic and public health. The application document showed a depth of knowledge and a commitment to public health.[18]

Chiropractor members of the APHA have served on various APHA committees and held various officer posts within the APHA. Articles by chiropractor authors and about chiropractic care have been published in the *American Journal of Public Health* and *The Nation's Health*. Every year the chiropractic national associations and chiropractic colleges fund paper presenters, researchers, teachers, and exhibits at APHA annual meetings. Chiropractic students are encouraged to join the APHA as student members during their public health classes. The world's largest chiropractic trade paper, *Dynamic Chiropractic*, has for many years carried a regular column titled "Chiropractic in the APHA," edited by Dr. Rand Baird with contributions from various chiropractic authors.

The ACA and the Association of Chiropractic Colleges (ACC) maintain agency membership within the APHA.

Several chiropractic colleges have also done so for a number of years, and so did the Council on Chiropractic Education (CCE). The ICA did for over 20 years. The ACA and ICA have at one time or another passed official resolutions urging their own respective members, but also all chiropractors, to join the APHA and support public health. The ACA House of Delegates re-affirmed this position in 2008. The ACA has appointed a standing Committee on APHA for many years. National Public Health Week (NPHW) is an annual APHA activity in April and various chiropractic institutions have participated, with the ACA signing on as an official APHA partner, promoting the events in its publications and encouraging all its members to participate. ACA publications often feature public health topics and include a message that all chiropractors should be involved in public health and in the APHA. Notably the June 2002 issue of *JACA: Journal of the American Chiropractic Association* had a public health theme and a cover article titled "Public Health and Chiropractic—Meeting Somewhere in the Middle," which extolled chiropractic involvement in public health and quoted several chiropractic leaders who were APHA members.[19] An earlier article in the same publication explored the importance of chiropractic activism in the APHA to the chiropractic profession as a whole and to individual DCs, while detailing what chiropractic offered to the APHA, and ending with emphasis on gaining input to APHA policy making, which has far-reaching impact on health care decisions.[20]

An interesting side note is that throughout chiropractic history some individual chiropractors and some chiropractic groups have expressed opposition to certain standard public health practices, such as vaccination, immunization, fluoridation of public drinking water supplies, and pasteurization of milk and dairy products, and entered the political arena to debate or oppose, often successfully, those measures in their communities. With a philosophy of preferring natural, nondrug interventions and freedom of individual choice, their opposition is perhaps understandable in that context, but it would be a myth to assume that such opposition is profession-wide or even very widespread. The necessity and utility of vaccination, immunization, fluoridation, and pasteurization are in most respects a non-issue for the leadership and the majority of chiropractors today. All of these topics are presented in chiropractic college classes, and chiropractic colleges have always had required, not merely elective, courses in public health in their curriculum, prompting advocates to point out that some DC programs have more required public health classes than found in some MD training programs. Standard public health publications, including the *American Journal of Public Health* and *Morbidity and Mortality Weekly Report* (MMWR) from the CDC, are found in chiropractic college libraries. To varying degrees the chiropractic colleges also include teaching about the DHHS's Healthy People National Health Objectives as a framework for identifying the most significant preventable threats to health and establishing national goals to reduce these threats.[21]

Chiropractors in the APHA and Public Health

Opportunities for leadership and participation abound within the APHA structure, and the expanded knowledge base, plus the contacts and collegiality of being in the APHA fraternity, also stimulate interest and open extramural opportunities in other mainstream public health sectors. Many chiropractors and other professionals working at chiropractic institutions have made contributions to the efforts of the Chiropractic Health Care section and its predecessor, the Chiropractic Forum. These are unfortunately too many to discuss in detail, but the entire profession appreciates all the chairs, secretaries, elected and appointed officers, governing councilors, Action Board representatives, program planners, and committee chairs, some of whom served multiple terms in these positions. Many have also made presentations at APHA scientific sessions.

Several members of note have served in leadership roles on APHA-wide boards and committees. Some have also served outside the APHA. Hopefully their accomplishments will serve as models and inspiration for future chiropractors. Dr. Rand Baird is credited with pioneering modern chiropractic involvement in public health, using the APHA as the vehicle for participation. His efforts in leading the battles for chiropractic recognition within the APHA, establishing a Chiropractic Forum special interest group within the APHA, and coauthoring and successfully championing a new APHA policy regarding chiropractic are thoroughly described in the two articles reprinted at the end of this chapter.

At the 1995 APHA annual meeting, Dr. Mitch Haas introduced a motion on the floor of the Governing Council to establish the Chiropractic Health Care section to replace the Chiropractic Forum. After the motion passed, Dr. Haas then became the first chair of the new section. The following year, Dr. Haas was elected by the Intersectional Council to its Steering Committee. He served two terms on the Steering Committee, was secretary of the Council in 1997, and became chair in 2000.

Because of a vote in the Governing Council that year giving a new position to the Intersectional Council Chair, the Chiropractic Health Care section had its first member on the APHA Executive Board within 5 years of it charter. Dr. Haas was appointed by two president-elects to serve on the Annual Meeting Planning Committee and the APHA Bylaws Committee. As a member of the Planning Committee he was able to organize a special session where he had the honor of introducing the Surgeon General, Dr. David Satcher, and APHA past-president Dr. Barry Levy. Dr. Haas also served on the ad hoc Development Task Force and the Work Group on Universal Health Care. Finally, he served on the Committee of Affiliates from 2005 to 2006 and received a citation from the chair for his contributions.

Other chiropractors who have been appointed to APHA-wide service include Dr. Lisa Killinger, who served on the Task Force for Aging; Dr. Andrew Isaac, the CHC's first African American section chair, who served on the Diversity Task Force; and Dr. Christine Choate, who served as the Action Board's Operations Subcommittee co-chair.

Chiropractors have made contributions to other organizations and public health institutions as well. Between 1999 and 2002, Dr. Cheryl Hawk was a member of the Iowa Board of Health, Iowa State Preventive Health Advisory Committee, and the Director's Council of Scientific and Health Advisors of the Iowa Department of Public Health. Dr. Michael Perillo is currently the Public Health Emergency Preparedness Representative IV for the New York State Department of Health. His primary focus is development and evaluation of emergency preparedness initiatives for health care facilities, including 145 hospitals, 325 long-term care facilities, and 25 community health centers. In 2006, Karen Konarski-Hart, DC, was appointed to a multiyear term on the Arkansas State Board of Health by Governor Mike Huckabee and served a term as the organization's elected president. Dr. Konarski-Hart is believed to be the first chiropractor to serve as a president of a state board of health. Other chiropractic doctors have served as board members of their local health departments. Because of his experience with the APHA, Dr. Haas was elected Oregon's Affiliate Representative to the Governing Council. He was a member of the Oregon Public Health Association (OPHA) Executive Board and Executive Committee between 2002 and 2008, and served as OPHA president in 2007. Dr. Andrew Cohen became president-elect of the Hawaii Public Health Association before leaving the state to practice elsewhere. Other chiropractor members of the APHA have served in other capacities in various health agencies, public and private.

Two articles detailing the history of the chiropractic profession's involvement have been published in *Chiropractic History—The Archives and Journal of the Association for the History of Chiropractic*. Dr. Herbert Vear authored the first, which appeared in 1987. The second article, by Dr. Jonathon Egan with coauthors Dr. Rand Baird and Dr. Lisa Zaynab-Killinger, appeared in 2006 and was designated by the journal as its "best article of the year." Together these two articles provide an excellent chronology for the reader, but perhaps more importantly can serve to illustrate what can be accomplished with dedication and perseverance by chiropractors working together for public health. Much has been done and much more remains to be done by chiropractic in public health through the APHA. Role models, precedents, and examples for the future participation abound in these articles, and they are reprinted here with permission (tables and photos omitted).

The Anatomy of a Policy Reversal: The A.P.H.A. and Chiropractic, 1969 to 1983

Herbert J. Vear, DC[22]

Although all CCE accredited colleges provide core curriculum education in public health to meet state and provincial statute requirements, there is little historic evidence to suggest that the chiropractic profession has been active or supportive in matters of public health with the possible exception of that for orthostatic posture evaluation. There are several valid reasons for this isolation from mainstream public health, all of which parallel the explanations for the historic isolation of chiropractic practice and education from the scientific health community. This paper traces the process of involving the profession with the American Public Health Association, and the 14-year campaign that turned around the policy of this organization toward chiropractic.

State and provincial chiropractic statutes in North America require examination of candidates for licensure in one or more of the following public health subjects: hygiene and sanitation, public health, toxicology and microbiology; however, there is little evidence to suggest that the chiropractic profession has been active

or supportive in matters of public health. The labeling of chiropractic as a "marginal profession" by Wardwell[1] in 1951 and later as "deviant" and "unorthodox" by others[2] did little within the chiropractic profession to encourage support of public health issues. Since its origins, survival of chiropractic as an independent health care profession was more important than support of medically dominated public health measures.[3]

Chartered in 1872 the American Public Health Association (APHA) is the largest, oldest and most prestigious, multidisciplinary public health organization in the world. In November 1969, the APHA passed a policy resolution, No. 6903: Chiropractors and Naturopathy,[4] which was based almost entirely upon the biased Department of Health Education and Welfare (DHEW) *Independent Practitioners Under Medicare Report*, mandated by the U.S. Congress.[4] The Congress, in planning the Social Security Amendments of 1967, PL 90-248, decided it needed more information about health care disciplines not included in Medicare legislation, before enacting amendments to Title 17 of the Social Security Act. The DHEW Report was refuted by a unified chiropractic profession response which encouraged the Congress to ignore DHEW recommendations. The APHA action in adopting a strong anti-chiropractic policy (No. 6903) appears to have gone unnoticed by the chiropractic profession in 1969.

The first record of any communication to the APHA information on the status of chiropractors is credited to Rand Baird, D.C., M.P.H., who wrote to John H. Romani, APHA president, on May 16, 1979. At that time, Baird was a student at the Cleveland College of Chiropractic in Los Angeles and also an instructor in Public Health. He asked the following questions:

1. Does the APHA have a policy statement regarding the role of Doctors of Chiropractic? 2. Does the APHA recognize chiropractors as primary physicians? 3. Are chiropractors eligible for APHA membership? 4. Have there been any articles in the *Journal*, either for or about Doctors of Chiropractic and their function in the health care delivery system?

Baird received a response on June 25, 1979 from Katherine S. McCarter, MHS, Director of Government Relations for the APHA:

> Enclosed is a copy of a resolution, adopted by the Association, which states that APHA considers the practice of chiropractic and naturopathy hazard to the health and safety of our citizens.
>
> While chiropractors are not specifically excluded from membership, very few have joined (less than 10) in light of our policy on the issue of chiropractic and naturopathy.[8]

Baird concluded that there was no occupational category for chiropractors because of Policy No. 6903. This resulted in an exchange of correspondence with the Director of Membership Services, Harold Cary, between July 1980 and October 1981.[9] Baird made the following points in his letters: "I chose #14, 'Drugless Practitioners,' because I could not find a category for 'chiropractor' nor 'chiropractic physician' . . . this is a serious flaw, and as a concerned member, feel it may be discriminatory as well . . . you [should] remedy the situation by either establishing a new category for 'chiropractor' or 'chiropractic physician'."

Cary acknowledged that when the occupational categories were revised several years ago no one had ever expressed concern for the omission of a chiropractic category. Cary stated further, "yours is the third letter indicating a change should be made. This is good timing since we are planning to purchase a new computer soon which will necessitate the rewriting of every one of our membership programs." The last letter in the exchange is dated October 13, 1961, and confirms that the new Codes Pamphlet lists "chiropractic physician" under Code 14. In the meantime Baird had recruited over 200 new chiropractic members, mostly students from Cleveland Chiropractic College of Los Angeles. The preceding events encouraged him to study the APHA Constitution, bylaws and policy making procedures with a goal of reversing the negative APHA chiropractic policy.

Baird contacted the American Chiropractic Association (ACA), the International Chiropractic Association (ICA) and the California Chiropractic Association for assistance. The ICA responded favorably by sending a representative to attend the APHA meeting in Los Angeles, November 1–4, 1981. The California Chiropractic Association agreed to sponsor a chiropractic exhibit booth. The booth was a first for chiropractic and was staffed by chiropractic physicians and students from Cleveland College.

Although the APHA has a procedure for introducing changes or amendments to existing policies, it is possible to submit a "late breaking" resolution to the Joint Policy Committee (JPC) for their consideration during the annual meeting. Baird prepared a chiropractic "late breaking" resolution for the annual meeting in Los Angeles." The JPC decided not to consider the resolution since the arguments in the resolution did not qualify it as a true "late breaker." This meeting hardened the

determination of the chiropractic participants to change the APHA chiropractic policy at the next annual meeting in November 1982. There was an obvious need for an improved chiropractic identity within the APHA, which would be served best by forming a chiropractic special primary interest group (SPIG).

Following the 1981 Annual Meeting Baird made formal application to APHA to form a "Forum on Chiropractic Health Care."[12] A response to this request was not forthcoming until April 21, 1982. The application "was disapproved by the Executive Board," The letter went on to say that:

> the Board felt that chiropractors should be welcome as individual members of APHA; however, in view of the current policy of the Association regarding chiropractors, the Board did not feel chiropractors should be a special group of the association at this time. The door was left open with this statement; The Board noted that this policy could be changed, but it is up to the group to change it.[13]

On June 4, 1982, Baird received his first formal encouragement from the APHA Joint Policy Committee (JPC) to pursue his objective in having 6903 repealed and replaced with a new policy.[14] They had reviewed, thoroughly, the resolution "Chiropractic Health Care," of November 1981 and also a revised version submitted early in 1982. The letter explained in some detail what was expected in order to supersede 6903. Baird rewrote his chiropractic resolution and the new version was submitted for publication in *The Nation's Health*, September 1982.[15] News of this appeared in an ICA news release, along with a review of Baird's accomplishments in advancing the chiropractic cause with the APHA.[16] This article prompted the author to write Baird and pledge the support of Western States Chiropractic College[17] and to write to Ernest Napolitano, President of the Council on Chiropractic Education (CCE) requesting that he join the APHA on behalf of the CCE. The author was appointed as the official CCE spokesperson at the public meetings.

Baird's acknowledgement of WSCC support was accompanied by a request for letters of support to be written to the Co-Chairpersons of the JPC of APHA.[18] WSCC, along with other chiropractic institutions and associations, responded to this request.[19–22] Baird was now receiving strong support from the ACA and the ICA. G. M. Brassard, Executive Vice-President of the ACA, had joined the APHA as an individual member and planned to attend the hearings in Montreal on November 22, 1982. Arrangements were made for all chiropractors attending the meeting to meet beforehand and plan a strategy for the public meeting.

Eight people met beforehand to plan a strategy for the public meeting, With a maximum of thirty minutes to present and defend the resolution, it was decided that Baird would present the position paper, "Testimony on a Chiropractic Policy Proposal."[23] Fred Colley, Ph.D., a microbiologist at Western States College of Chiropractic, would speak to his experience as a public health teacher at both a medical and a chiropractic school. Walter Wardwell, Ph.D. from the University of Connecticut would present a sociological viewpoint of chiropractic. Gerald Brassard, D.C., the Executive Vice President of the ACA, would reinforce the gains made by the profession since 1969 and Herbert J. Vear, D.C., F.C.C.S., the President of Western States, would speak to the accreditation process in chiropractic education. Also present at that meeting were Karl Kranz, D.C., representing the ICA, James Watkins, D.C. of the Canadian Chiropractic Association and Robert Wakamatsu, a student at Cleveland Chiropractic College, Los Angeles.[24]

The Resolution went uncontested at the public meeting. The absence of public opposition to the resolution from the Medical Section of APHA suggested that opposition would surface either at the JPC or Governing Council meetings. The Policy Committee-C decision was to present the chiropractic resolution to the JPC the next day as being uncontested. On November 23, the chiropractic contingent lobbied for support and planned strategies while the JPC met in closed session.

It was learned during the day that opposition to the resolution would occur the following day during the Governing Council meeting. As predicted, the Medical Care Section (MCS), the largest section within the APHA, spoke against the resolution and used a delaying tactic to avoid having it come to a vote. Their strategy was to have the chiropractic resolution studied by an unnamed committee.[25] Interestingly, the APHA Executive Board Minutes, November 12–18, 1982, "reported that a resolution was coming before the Governing Council which seeks an endorsement of chiropractic and which would supersede the 1969 resolution."[26]

On November 24, the chiropractic resolution surfaced for discussion by the Governing Council. The original resolution had been altered in content by the JPC but not beyond acceptance.[27] The main objective was to have the 1969 resolution rescinded even if a new resolution could not be passed. During the discussion, attempts were made to further alter the wording of the revised resolution, particularly changing

the phrase "primary care" to "limited care" and the phrase "licensed primary providers" to "licensed limited providers." The Governing Council, after two amendments to the resolution, voted to table the resolution until a committee selected by the Board of the APHA could discuss the resolution. The chiropractic representatives were disappointed but realized, without a spokesperson on the Governing Council, the resolution had no other route to follow. The major concern was the attempt to use the word "limited" to replace the word "primary." The chiropractic representatives met to examine the day's events and plan. Two actions were agreed to; first, the contingent would continue as an Ad Hoc Committee to plan for 1983 and, second, to encourage membership in the APHA—Radiological Health Section, by chiropractic physicians and students. It was the committee's opinion that the Radiological Health Section with only 250 members offered the best opportunity for the profession to have a chiropractic member of that section elected to the Governing Council to speak on behalf of chiropractic at Governing Council meetings.

Shortly after returning from the APHA meeting, Brassard contacted Wardwell and former ACA president S. Owens, both of Connecticut and close friends of the newly elected APHA President-Elect, Susan Addis. He asked for their help in having Baird either appointed to the special committee to study the chiropractic resolution or to be, at least, the senior chiropractic consultant to the committee.[30] On the same date, Brassard wrote to the APHA Executive Director and requested a chiropractic presence on the committee.[31] These actions prompted the author to write to the APHA president on behalf of CCE and offer the CCE's cooperation with the Executive Board.[32] Brassard continued with his contacts "on the APHA chiropractic resolution," and on December 1, 1982 recommended seven actions to Baird.[33]

In the meantime, Baird was planning his response to the Governing Council's action of November 24, 1982. He wrote a letter to the new APHA president, "to protest the actions of the Governing Council and Executive Board in allowing the MCS to defer voting on the 'Chiropractic Health Care' proposed resolution."[34] As Baird noted, correctly, the "only specific issue raised by the MCS was on the current relevancy of the 1968 DHEW findings on chiropractic education and practices." Baird enclosed and sent under separate cover two important documents to support the findings of his letter of protest.[35,36] He attached an introductory note which emphasized an important observation, "one additional salient issue is the fact that APHA based its policy #6903 on the DHEW study; there is no internal APHA committee study of chiropractic art and science."

In anticipation of the January 13–14, 1983 meeting of the APHA Executive Board, Baird, Brassard and Kranz prepared a statement on the "Chiropractic Health Care proposal (1982)."[37] No chiropractic representative appeared at this meeting. The following are extracts from the minutes:

> Dr. Robbins stated that the first order of business is to examine the scientific basis of chiropractic, and he urged that an individual be selected to review the state of the art and report back to the Board on the current status of chiropractic. He felt that the important thing here was to conduct the study, not establishing yet another committee.
>
> Dr. Walker believed that the Governing Council had assigned the Board a fact-finding task, not a judgmental one, but the Executive Director commented that there were those on the Governing Council who felt that to consider this as purely a scientific issue would overlook such matters as choice of care, or inequities in holding chiropractors to a scientific standard that is not applied to, for instance, health administrators, Dr. Robbins, however, felt that it was important to separate these points from the scientific questions because otherwise they become blurred together. Dr. Johnson, agreeing with the approach suggested by Dr. Robbins moved, and it was seconded, that an individual be engaged to conduct a literature search and prepare a document for the Board's review on the scientific basis of chiropractic. The motion passed but not unanimously.[38]

The APHA commissioned Sylvia Simpson, M.D., M.P.H., to prepare a background paper on chiropractic as directed by the Executive Board. The paper, titled "Background Paper on Chiropractic"[39] was submitted to the APHA on April 6, 1983.[40] This 21 page paper with 34 references was generally favorable to chiropractic.

The weakness in the Simpson paper is its reliance on very dated chiropractic concepts, discredited early studies (e.g., DHEW, 1968) by adversaries, and no reference to legislative, educational and research achievements since 1968. The objective for the "Background Paper" was to examine the scientific support for chiropractic, it is unfortunate that a more serious effort was not made to accomplish that goal.[41,42] However, the Baird response[43] was charitable with the following comment: "for a background study on

chiropractic, Dr. Simpson's paper was fairly accurate; however, it is only a brief and very general overview of the profession." The ACA response was less charitable with the following comment:

> Unfortunately, it suffers from two major research flaws; hopelessly outdated statistics and data, and omission of information essential to the subject matter. The outcome is a report which leads its readers to numerous inaccurate impressions about chiropractic health care and its providers.[4]

Not one of Simpson's thirty-four references is dated after 1952. Only three chiropractic references are noted and two of these were cited in the DHEW report. There is no evidence that Simpson interviewed any chiropractic educators or requested current information from any chiropractic source. The importance of Council on Chiropractic Education publications, particularly "Educational Standards for Chiropractic Colleges Manual," were ignored. Equally ignored were college catalogs, which list all faculty educational qualifications.[44]

Acknowledged to be out of context, the following are examples of statements made by Simpson: "Chiropractors do not recognize other causes of disease, such as micro-organisms.[45] Chiropractic places much less emphasis on diagnosis than does orthodox medicine.[46] Chiropractors reject surgery, drugs and immunizations as violating the sanctity of the human body.[47] Now most schools require two years of college. Now many schools require that their basic science faculty have graduate degrees.[48] Users tend to be older, report more chronic health problems, have used physicians relatively frequently, but report difficulty getting doctors (M.D.) appointments."[49]

The two chiropractic responses not only corrected the above misconceptions, but went on to detail the higher education gains made by the profession since 1968. Both reports quoted from the Council on Chiropractic Education Standards[50] with emphasis on admission requirements, standard chiropractic degree program, diagnosis, scope of practice, cause of disease, academic educational standards required by all faculty, and practice standards.

The Baird response[51] is noteworthy in response to the statement by Simpson, that "chiropractic sees itself as an integrated healing system, separate and distinct from orthodox medicine,":

> In our view only part of the above statement is correct. Chiropractic is indeed a separate and distinct healing art, philosophy, and science in contrast to traditional orthodox medicine. We hesitate to suggest however that it "is a complete integrated healing system." In the words of the New Zealand Royal Commission, "Chiropractors do not provide an alternative comprehensive system of health care, and should not hold themselves out as doing so." Chiropractic has been forced to practice isolated most of the time as a result of the ostracism it has been faced with. In any case, we generally see chiropractors as being practitioners of "limited primary health care." Chiropractors are primary care practitioners to a degree by virtue of the fact that patients may consult them directly and as such may gain entry to the general health care system. At the same time, chiropractors are "limited" in that they do not offer the comprehensive services often required in acute crisis care situation. In contrast, however, most medical physicians are "limited," type practitioners considering that they don't generally provide all the services necessary to completely serve their patients.

This reference to chiropractic as a "limited primary health care provider" is one of the first times that this description has been used by the profession to clarify the role of chiropractic in the health delivery system.

At the April 14–15, 1983 APHA Executive Board Meeting four actions were taken.[52] *First*, the Executive Board designated itself as the referral group for further study of chiropractic policy issues and was to report its conclusions and recommendations to the Governing Council after considering the staff-commissioned background materials on chiropractic and a discussion with the chiropractic at its July meeting. *Second*, the question of a Chiropractic Special Interest Group was examined with the following action, "that the issue would be considered at the next meeting." *Third*, by motion the Board favored proposing a new resolution to replace 6903, based on the "Background Paper" and other materials. *Fourth*, application by chiropractic organizations to become agency members was deferred until the Board arrived at a final decision. Under the continuing leadership, of Baird, Brassard and Kranz, plans were made to attend the July 14–15, 1983 meeting. The American Chiropractic Association and the International Chiropractors Association actively encouraged their members to join the APHA to strengthen the chiropractic presence. Both ACA and ICA passed resolutions in support of participation in a national public health forum.

At the APHA Executive Board Meeting on July 14–15, 1983, lengthy discussion took place on the "complex" question of chiropractic policy issues.[53]

The chiropractic profession was represented by Baird, Brassard. Kranz, and Wardwell. As spokesman for the chiropractors, Baird acknowledged that "they found the proposed substitute resolution almost completely acceptable, with a few revisions." Board member Sheps raised his concern for the "scientific validity" of the larger group of practitioners called "mixers," who supplement their spinal manipulations with "more questionable" therapies. He also expressed concern for the "sharp differences" in therapy used by the liberal and conservative practitioners. Baird provided an excellent answer in stating "the philosophical approaches to problems of health and disease are different for the two professions, but the bio-scientific basis for any health profession is grounded in two sciences, anatomy and physiology." He defended the chiropractic use of, for example, ultrasonics, by explaining that chiropractors utilize such modalities in exactly the same way as physical therapists and medical doctors.

Following the chiropractors' presentation, the Board met in private and "debated the chiropractic issues exhaustively." Typical of these issues, as recorded in the minutes,[55] was that

> many chiropractors do not limit themselves to those professional services which have been demonstrated to be safe and effective, and in fact some patients turn to them for complete care. The Board felt that there is a potential for harm and; they may treat conditions for which they are not properly trained, they may misdiagnose, and appropriate treatment may be delayed.

The Executive Board went on to approve a resolution for submission to the Governing Council in November, and approved formation of a Chiropractic Special Interest Group, however they denied agency membership until the fate of the resolution was decided.[56] The SPIG was established in September 1983, with Kranz as interim chairman. The APHA Executive Board announced its chiropractic decision in the association's publication, *The Nation's Health*.[57] On September 23, 1983, Baird was mailed a "draft" copy of the chiropractic resolution proposed by the Executive Board.[58]

At the long-awaited meeting of the APHA Governing Council on November 11, 1983, the proposed compromise chiropractic resolution finally surfaced for discussion. Since Baird had been elected a Governing Council delegate for the Radiological Health Section in 1984, the council suspended its rules and allowed him to speak on behalf of the resolution. The text of Baird's remarks are short, but of sufficient importance to be restated.

> Thank you for suspending your rules and allowing me to speak. I have been asked to represent the chiropractic profession, and its organizations known as the American Chiropractic Association, the International Chiropractors Association, the Council on Chiropractic Education, and the Canadian Chiropractic Association, altogether totaling over 30,000 people, as well as several hundred chiropractor members of the APHA.
>
> I am here now to represent our interests, and to answer your questions.
>
> In response to the issue on the floor, the chiropractor members of the APHA do not agree with everything in the background paper by Dr. Simpson. But we are willing to accept it for what it is. It is an attempt to be objective, and to encompass many different viewpoints into a single summary document. Likewise, we do not fully agree with the alternative resolution proposed by your Executive Board. But as a compromise to which we had some input, we are willing to accept and support it.
>
> A three year process, including a year long consideration by your Executive Board, led to this carefully worded compromise resolution. This is a free choice issue, this is a membership rights issue, this is a fair play issue.
>
> APHA is a multi-disciplinary organization.

Following Baird's presentation and the endorsement of the Governing Council, resolution #8331 passed.[60] On November 14, 1983 the Dental Section and the Medical Care Section attempted to have the chiropractic resolution overturned but they were overwhelmingly defeated by the Governing Council and Executive Board majority.

The Chiropractic Special Interest Group has sponsored in 1985 and 1986 the presentation of educational, technical and scientific papers on chiropractic which have been well attended and applauded by the multidisciplinary audiences. Regardless of the comfort the profession may take from adoption of a new policy on chiropractic by the APHA, there is still a great deal of concern within the hierarchy of the APHA for chiropractic patient care.[61] It is this author's opinion that the positive manner in which the prestigious APHA was encouraged to reverse its harsh policy on chiropractic health care should serve as a model for others seeking to change policy or opinion of like organizations.

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Chiropractic within the American Public Health Association, 1984–2005: Pariah, to Participant, to Parity

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Chiropractors were granted the right to form a group identity within the American Public Health Association (APHA) at the conclusion of 1983 after an official anti-chiropractic policy was reversed. Beginning in 1984, chiropractors began serving alongside other public health professionals within this prestigious association, the world's oldest and largest public health organization. Although permitted a group identity within the APHA, chiropractors still had to overcome many obstacles to full participation, including professional bias, misunderstanding, and struggle within the ranks. By 1995, chiropractic succeeded in achieving full APHA section status, or full equivalence to other health professions within the APHA. The year 2005 marked the tenth anniversary of this achievement. This article traces the history of chiropractic within the APHA from the early years of acceptance to the eventual celebration of a decade of full parity.

The year 2005 marked the tenth anniversary of the Chiropractic Health Care (CHC) Section within the American Public Health Association (APHA). In that year, two elected chiropractors and the section chair of the CHC section served on the Governing Council, the official policy making body of the APHA. There were 17 scientific and technical papers authored by 37 chiropractic co-authors presented in 4 sessions at the 133rd annual meeting of the APHA in Philadelphia, PA in December 2005.

In this and other recent years, chiropractors have been found at all levels of the APHA, having served on the Executive Board, published in the prestigious *American Journal of Public Health (AJPH)*, functioned in various leadership positions, and coordinated the activities of the CHC section. Chiropractors have received several significant honors within the APHA, including awards of distinguished service, the opportunity to personally introduce the United States Surgeon General at the Annual Meeting, and recognition for individually recruiting more members than any other member in the history of the association.

Chiropractic has full parity within the APHA, serving alongside over 50,000 other professionals who advocate for health promotion, disease prevention, and healthy individuals and communities. This parity has made the APHA a powerful ally. Indeed, when the profession in the form of the World Federation of Chiropractic (WFC) sought official relations with the World Health Organization (WHO) in 1996, the World Federation of Public Health Associations (WFPHA) officially endorsed the application to WHO. This support came about specifically because of chiropractic involvement with the APHA, a significant member of the WFPHA.

This full parity as health professionals within the APHA did not always exist. As late as 1983, the APHA had an official policy against chiropractic. Chiropractors were considered a threat to the public health per APHA policy #6903. Through this policy, the APHA called on friends of public health throughout the United States to pursue the revocation of licensure of chiropractors in each state. That policy stood from 1969 to 1983—14 years!

In 1987, Herbert J. Vear, DC, outlined the overturning of that policy in "The Anatomy of a Policy Reversal: The A.P.H.A. and Chiropractic, 1969 to 1983" in *Chiropractic History*. In that paper, Vear described how chiropractic student Rand Baird, MPH approached the APHA in 1979 to determine their openness to chiropractic. It was then that the profession became aware of the anti-chiropractic policy. Vear described Baird's efforts to get chiropractic a "profession code" within the APHA, so chiropractors could join the APHA as chiropractors despite the anti-chiropractic policy. Vear outlined the efforts of chiropractors, chiropractic colleges and chiropractic associations to push for policy change from within the APHA after joining it. In 1983, chiropractors were permitted to form a Special Primary Interest Group (SPIG), called the Chiropractic Forum, though chiropractic organizations and colleges did not yet achieve status as APHA affiliated agencies. Late in 1983, policy #6903 was reversed with #8331, a compromise policy that supported chiropractic on a limited basis.

Some groups, such as the Dental Care Section, had opposed passage of policy #8331 and also tried to block agency membership for chiropractic organizations. They did so by noting what they described as the historic opposition of some chiropractors to well-established public health measures such as drinking water fluoridation. As that opposition was raised,

Rand Baird, DC, MPH said to the assembly, "We'll toast the Dental Care Section by drinking a glass of Anaheim fluoridated drinking water right here." Though Dr. Baird was ruled out of order, the wry humor succeeded and the new chiropractic agency members were allowed.

For full details on reversal of policy #6901 and the passage of policy #8331 see the Vear paper. Chiropractic involvement in the APHA since the reversal of that policy from 1984 forward will be further outlined here.

The Council on Chiropractic Education (CCE) formed a Panel on APHA in 1984. The first chair and members were Dr. Rand Baird and Drs. John Barfoot, Karl Kranz, and Herbert Vear. A significant first for chiropractic occurred this year, as Dr. Baird was elected to the Governing Council of the APHA by the Radiological Health (RH) section, the section most chiropractors joined to allow professional representation within APHA through aggregated numbers. The path was becoming clear for increased chiropractic participation, and shortly thereafter both the American Chiropractic Association (ACA) and the International Chiropractors Association (ICA) passed resolutions encouraging all their chiropractor members to join the APHA as a nonsectarian profession-wide venture.

Because chiropractors were now welcome as a profession within the APHA and had achieved a group status and identity, 1985 became a year of many more firsts for chiropractic. Chiropractors had previously operated booths in the exhibit hall at the annual meeting. 1985 was the first year that chiropractors presented scientific and technical papers within the APHA at the annual meeting. Those annual presentation sessions comprise the educational program, and have been a prestigious venue for researchers, educators, and clinicians to present their work to multidisciplinary audiences in the years since. Dr. Rand Baird became the first chiropractor to serve on any APHA committee, serving on the Election Tellers committee. (The appointment of Dr. Baird to this committee by Dr. Victor Sidell, MD, APHA President, was a real show of support. Dr. Sidell had already played a key role in helping chiropractic gain acceptance within APHA.)

Chiropractors were invited to participate in the Governing Council elections for unaffiliated members (from the chiropractic SPIG, as chiropractic still lacked its own official full section). They further continued service as members of the Governing Council from the RH section. Another significant first showed the power of membership in a membership-driven professional organization: When contacted during the election process, each candidate for the President-elect and Executive Board within the APHA this year expressed support for the role of chiropractic within the APHA.

Despite these gains, a problem that would haunt chiropractors organizing within the APHA became evident, even at this early stage. Many chiropractors—and especially chiropractic students—were joining the APHA, yet few were renewing membership. In 1986, despite 101 new chiropractic members in the RH section, there was no net gain in membership because 176 chiropractic members failed to renew. Similarly, the Chiropractic Forum SPIG had 113 new members but 134 did not renew their membership. Though the Chiropractic Forum remained the largest SPIG within the APHA, it was observed that it would have been 25% larger if chiropractic members would renew their membership. As will become clear, chiropractic enfranchisement within the APHA would be threatened because of high non-renewal rates. However, chiropractic yet remained enfranchised, which continued to provide unique opportunities for chiropractors to engage their fellow health professionals.

In late 1985, another difficulty that would follow chiropractors within the APHA was the failure of elected members to fill their leadership roles. A true leadership crisis appeared this year, when the Vice-Chair and Secretary-Treasurer did not fulfill their duties, the Program chair/Unaffiliated Governing Councilor resigned, and the elected Chair resigned due to health problems. Dr. Karen Larson took the helm for 1986–1987 and did a remarkable job leading the SPIG through a leadership crisis. In 1986, Dr. Vear announced his intention to transfer from the RH section to the Chiropractic Forum to help provide leadership there.

In 1986, Dr. Baird questioned the candidates for the APHA Executive Board. He queried: "Although APHA has a SPIG Chiropractic Forum and several hundred chiropractic doctors, chiropractic educators, and chiropractic students, as well as four agency members, there still seems to be some controversy about chiropractic participation in APHA; what is your opinion of chiropractic participation in APHA?" He received uniformly favorable responses from all candidates.

At the 1987 annual meeting, all of the chiropractic presentation sessions were attended by Ruth E. Parry, M.A., M.A.S., a representative of the Veterans' Administration (VA). She explained that she was attending to learn about the chiropractic profession, including

education and scope and standards of practice. She did not share her specific opinions of what she heard that day beyond being generally pleased with the presentations. However, chiropractic was clearly "on the radar" within the APHA. Organizations were taking notice and taking the opportunity to learn about the profession from chiropractors at their educational program paper presentations.

Relationships between APHA and chiropractic organizations were developed and strengthened throughout the decade. In 1987, the ACA established its Committee on the APHA. Dr. Vear served as the first chair of this committee, whose inaugural members included Drs. Baird and Lee Selby. (Dr. Baird had also served as the ICA representative to the APHA annual meeting each year from 1983–2003, and others occasionally served the ICA in this role.) The ACA panel in essence filled the role the CCE panel served for the prior 4 years, and so in 1988 the CCE panel was dissolved, though the CCE retained affiliated agency status with APHA. As chiropractors affiliated with the APHA continued to refine these professional relationships, it became clear that increased coordination was needed with other chiropractic groups interested in public health. In 1989, officers of the chiropractic SPIG, RH section, ACA APHA panel members, the ICA representative, and ACA executive board liaison enhanced inter-organizational communication and coordination in an attempt to eliminate the duplication of effort. Common purposes forged stronger relationships. Despite this, at year's end there was no formal contact between chiropractors in the APHA and chiropractic college public health instructors, the Association of Chiropractic Colleges (ACC), and now the CCE.

By 1989, chiropractors represented a majority of the membership within the RH section for the first time (189 out of 341 members). As chiropractic representation grew, so did the number of chiropractors serving as officers within the section. In 1989, chiropractors served in every leadership position within the RH section except the Section Chair—a deliberate strategy to prevent alienating the non-chiropractic membership of that section. However, many chiropractors were again elected that did not or could not fulfill their responsibilities.

Despite the aforementioned difficulties in retention and in the failure of some elected to leadership to serve, the dedication of several determined individuals and the support of several professional organizations and schools made the difference. Chiropractic survived and continues within the APHA due to the efforts of a core group of active members and leaders who diligently championed the role of chiropractic within public health. Many volunteered, some even taking unpaid leave from private practices to serve the greater good of the chiropractic profession. Colleges and associations sponsored many others. These individuals eventually helped achieve parity for chiropractic within this prestigious multidisciplinary association.

In 1990, a national health program appeared likely to succeed under the direction of the Clinton Administration. The Chiropractic Forum SPIG frequently pondered the role chiropractic might fill in such a system. Members of the group felt concerned that there did not appear to be a national chiropractic strategy at any level to help shape the national health care policy from chiropractic's point of view. Members of the SPIG were concerned that it was unclear if mandated coverage would be determined at the state or national level and that chiropractors were not engaging this policy debate.

Another concern in 1990 was that the ICA had created new policies against immunization and drinking water fluoridation. Immunization and fluoridation are widely accepted public health practices and it was feared that these ICA policies would not be well received within APHA. Further, the ICA was an agency member of the APHA, and these policies appeared to contradict other verbal statements by the ICA made when it applied to be an APHA agency member. A related concern raised in 1990 was that chiropractors lacked interest in the overall public health effort because the public health education given chiropractic students may have overly focused on fluoridation and immunization. This strong focus on these "hot-button" issues appeared to be made at the expense of broader public health issues—and potentially at the expense of the role chiropractic could play in public health. To address this concern, Drs. Baird and William Meeker were asked to prepare a sample syllabus for a chiropractic public health course. At the same time, they were asked to consider and make recommendations for the apportionment of questions for national board exams in public health and microbiology that would reflect the enlightened curriculum.

Old problems persisted in 1990. Several elected members did not serve or show up for meetings and

retention remained unacceptably low, preventing the SPIG and the RH section from reaching their potential. Compounding the problem this year was that the call for abstracts for the annual meeting of the APHA was not appropriately published within the profession. A relatively poor response ensued. Further, though chiropractors had been formally admitted to the APHA for 5 years, no chiropractic-authored paper had yet appeared in the prestigious *AJPH*. Dr. Baird had two letters published in *The Nation's Health*, the periodical of the APHA, and two letters to the editor in *AJPH*, but no article authored by chiropractors had yet appeared in *AJPH*.

Chiropractors within the APHA attempted to address many of these problems in 1991. To address membership, *Dynamic Chiropractic* offered to donate advertising space, run a recruiting article, and include membership applications to the APHA. Leadership service improved, with only one member not attending the annual meeting this year, yet still submitting a report. To address the public health issues of immunization and fluoridation, chiropractic members of the APHA recommended that the ACA take an official stand in support of these public health measures. To improve attendance at chiropractic presentations at the annual meeting, the SPIG and the RH section determined to have copies of each other's programs within their booths. In spite of errors in the publication of the "Call for Abstracts" for the annual meeting educational program in many chiropractic venues that year, chiropractors were making progress within APHA.

Positive events in 1992 included Dr. Baird's appointment from the RH section to the APHA Committee on Membership, only the second time a chiropractor was appointed to a national committee within APHA. In 1992, a pro-chiropractic APHA president (Helen Rodriguez-Trias, MD) was elected who would begin service in 1993. Dr. Rodriguez-Trias would prove an important ally now and years later when official section status was sought. Also in 1992, Dr. Vear presented the proposed draft of a pro-vaccination policy for the ACA to consider endorsement. Fluoridation was discussed as well. Most Chiropractic Forum members present at the annual meeting voted to support these policies. They felt, as do almost all in the public health field, that immunization and fluoridation are proven public health tools. The group again recommended that the ACA adopt positive official stands on vaccination and immunization as an agency member, especially in light of the ICA's perceived opposition to these measures.

Dynamic Chiropractic and other publications again helped publicize the need for chiropractors to join the APHA. This year, the "Call for Abstracts" received much better attention. At the 1992 annual meeting when the presentations were given, four medical epidemiologists from the Centers for Disease Control and Prevention attended the chiropractic session on immunization. These epidemiologists appeared genuinely interested in the presentations.

Despite gains in recruitment, 1992 was a critical year for membership. The chiropractic SPIG had the 4th best recruitment rate but the absolute worst retention rate of all APHA SPIGs. The RH section had the 8th best recruitment rate of all 24 sections within APHA, but ranked a dismal 23rd in retention. Because of this, there was another net loss in membership in both the SPIG and the RH section. Membership is critical for the retention of section status—and the voting seats on the Governing Council and APHA budget allocation that come with such status. As long as chiropractors were represented in an official section (in this case, the RH section) and had members on the Governing Council, they were able to help shape APHA policy. Otherwise, they effectively stood to lose representation and identity within the APHA. If chiropractic did not have 250 members in the RH section by September 1993, the section could be disbanded. All that had been accomplished over the last 13 years in the struggle for recognition of chiropractic within APHA would be lost.

Chiropractors worked hard at recruitment, and in 1993, chiropractors within the APHA reaped the rewards of their labors. Many chiropractic publications—especially *Dynamic Chiropractic* and those of the Foundation for Chiropractic Education and Research (FCER) and the ACA—had discussed the possible loss of enfranchisement and voting seats if more chiropractors did not join the APHA. Dr. Baird authored several articles within *Dynamic Chiropractic* about the September deadline. As a result, 1993 was a huge year for recruitment. The RH section reached 614 members, with the best recruitment rate of all sections and the largest membership in the 28-year history of the section. However, the renewal rate remained the worst. The Chiropractic Forum SPIG grew to 352 members, reflecting the best recruitment rate among SPIGs. It also had its highest membership ever; its size even exceeded that of 2 official sections. However, its renewal rate was the very worst of all sections and SPIGs.

This growth did not escape the attention of the APHA, where it was noted that this August was one of the best single recruiting months in APHA history, largely due to the chiropractic response.

Subsequent to this tremendous growth and the fact that over 500 of the members of the RH section were chiropractors, consideration was given to changing the name of the RH section to reflect chiropractic participation. Chiropractors were satisfied with their relationship to the section; they simply wanted the name to reflect the interests of the group. Several names were discussed, including "Chiropractic Care and Radiological Health Section" and "Chiropractic Care and Radiation Protection Section." A committee was formed to prepare a 5-year plan for the section. The committee members were Bill Kirk, PhD, Dennis Murphy, PhD, Martin Meltz, PhD, and Rand Baird, DC. The plan would include the mission, vision, and goals for the section, which would help direct the naming process.

Because of the number of chiropractors now present in the APHA in both the Chiropractic Forum SPIG and the RH section, consideration was also given to having members of the SPIG transfer to the RH section if a name for the section was chosen that reflected professional identity. If this happened, the combined section would have strength exceeding 1,000 members, and would be the 11th largest section. Voting seats and budget would accompany size, and would afford great privileges to chiropractic within the APHA. As will be noted, the name change never happened, and events unfolded that would lead to chiropractic forming its own official section in the near future.

In recognition of service and recruitment, the RH section presented a Distinguished Service Award in 1992 to Dr. Rand Baird, the first time a chiropractor received such distinction in the history of the APHA. Dr. Baird also continued in his role on the APHA Committee on Membership, only the second time that a chiropractor served at the national committee level.

Several noteworthy events occurred at the 1993 annual meeting of APHA. First, Hillary Clinton spoke with APHA leaders about national health care reform. Second, Ian Coulter, PhD, gave a presentation at the chiropractic research sessions on how to think about health care policy issues. According to his abstract, "education as a health professional will not necessarily result in the ability to do policy analysis. Its purpose is to enable health professionals to become 'literate' about a broad range of health issues, many of which transcend their own discipline." As the profession continued to integrate and enter the mainstream, it was felt that Dr. Coulter succinctly expressed the need for chiropractors to become "literate" about health care issues larger than themselves. A third significant event was that an educational session at the annual meeting called "Alternative Care—Fad or Medical Failure" was held that was not co-sponsored by chiropractors and had 6 speakers, none of which were chiropractors.

Networking with other healthcare professionals is critical, and this represented a missed opportunity, as did the fact that chiropractors mostly had been presenting research to other chiropractors at these annual meetings. One example of the power and importance of networking with other professionals became evident at the 1993 annual meeting. Just as Dr. Sidell and Dr. Rodriguez-Trias were powerful allies who had been and would yet be tremendously helpful to the profession achieving parity, others with increasing familiarity with chiropractic would become friendly and helpful. The new incoming President for 1994 (who began service at the 1993 annual meeting) was Eugene Feingold, PhD, JD. He had formerly vigorously opposed formal chiropractic participation within the APHA. However, he later took part in the reaccreditation process for Palmer College of Chiropractic and was now satisfied with chiropractic's scientific base. He stated that he welcomed chiropractic within the APHA. Here, and in so many other occasions, familiarity with chiropractic brought new respect for the profession. Working in the APHA, which allowed chiropractors to work closely with thousands of similarly public health-minded practitioners, afforded many opportunities for building these new bridges of understanding.

1994 was another critical year. Echoing the failure of the Clinton health plan was a leadership crisis in the chiropractic SPIG. The elected chair of the SPIG, a non-DC, was removed from office after 11 months of failure to perform duties. Dr. Mitchell Haas took up the reins as acting chair after special election by the other SPIG leaders. This was a portentous time. There was a critical mass of chiropractors in the RH section and in the SPIG. The RH section had determined to change its name to "Radiological Health and Chiropractic Care Section," but the request to change the name was denied by the Executive Board of the APHA in July 1994. The Board suggested that rather than change the

name of a section organized around an interest, that chiropractors seek their own independent section. Strong leadership was essential here.

Six chiropractors accepted the substantial responsibility to complete the application for Section status within the APHA. Drs. Mitchell Haas (serving as chair), Rand Baird, William Meeker, Robert Mootz, Michael Perillo, and Fred Colley, PhD, agreed to do the considerable work assembling the materials required by the APHA. It took several months, but the opportunity represented the culmination of sixteen years of effort within the APHA.

As part of the strategy to become a full section, Dr. Baird suggested that 200 chiropractic members of the RH section switch their membership to the chiropractic SPIG. When this was done, there were over 500 members in the SPIG. At this size, the chiropractic SPIG was larger than all the other SPIGs combined and larger than 7 sections. It was also the largest SPIG ever—which placed chiropractic in a great position to achieve full section status with voting privileges on the Governing Council and full parity. These authors had until April 1995 to prepare the APHA section application for the chiropractic profession.

Despite the excitement among chiropractic members about the potential opportunity to become a full-fledged section, chiropractic continued to be plagued by non-attendance at the year-end APHA annual meeting. Three of the sixteen papers scheduled for presentation during the chiropractic sessions were simply not presented, because their authors did not attend the conference. One of the chiropractors scheduled to preside over a session failed to attend without providing notice. Dr. Craig Nelson substituted at the last minute for this individual, but credibility was still affected every time someone failed to fill the responsibilities they had accepted.

Three exciting developments from 1994 deserve final mention. First, the APHA officially supported California's Health Security Proposition 186. Though the proposition ultimately did not pass, this was a watershed moment, as the APHA gave as one reason for its support the fact that this proposition had chiropractic coverage as one of its benefits. In this and later political battles, it was clear that participation in this highly regarded organization was important for chiropractic and for public health. The APHA was a perennial strong voice on Capitol Hill—and now included chiropractic interests in its agenda. Another development was that the RAND Corporation, a scientific "think-tank," published studies on chiropractic that helped to further the chiropractic cause. A last development of note from 1994 was that a new SPIG formed: "Alternative Medicine." This SPIG had few members to start with, but had substantial interest. One of their sessions, "Alternative Methods of Medical Care," had an audience of 250.

April 1995—the deadline for the chiropractic section application—arrived. This excerpt from the 1995 ACA Committee on American Public Health Association annual report summarizes the events leading to full section status for chiropractic in APHA [original grammar, spelling, and punctuation retained except as noted]:

> The application and supporting documents were first submitted to APHAs Executive Board in March for the Board's April 17–18 meeting, deferred until May 9, 1985. After lengthy discussion and evaluation of the application according to the 1975 "APHA Criteria for Establishment of New Sections," the Board returned the application to the authors requesting additional information and more specific answers to some of the questions that accompanied the criteria. These were addressed and the application revised again, and resubmitted to the Executive Board which then reviewed it July 18, and determined its completeness, and scheduled it on the subsequent agenda of the Governing Council. . . .
>
> Throughout the Summer and Fall, the team members, especially Drs. Haas and Baird, continued correspondence and conversation with APHA leaders, Governing Councilors, and Executive Board members, answering questions and concerns and lobbying for the application. Varying degrees of support were elicited from Board Members. . . . Lively debate was encountered from [some].
>
> The Governing Council began the discussion of the Chiropractic section application on Wednesday, November 1, 1995 shortly after 9:00 am. Dr. Mitchell Haas as a Governing Councilor from the SPIGs, and Dr. Rand Baird holding a proxy from the Radiological Health chairman, were seated.
>
> When the Governing Council began the debate, several other well-known leaders in the scientific community spoke out for chiropractic! William Kirk, PhD, radiation physicist, spoke on chiropractors' expertise in radiation protection of the public. Victor W. Sidell, MD, a highly regarded former president of APHA and internationally acclaimed physician spoke about our dedication and our contributions. Letters of support were received by the Governing Council from Dennis Murphy, PhD, Chair of the Radiological Health Section, and from Helen Rodriguez-Trias, MD, another recent APHA past president. Professor Jon Lemke, PhD, from the Statistics Section, spoke about chiropractic research and praised Palmer College's research department.

> Ted Miller, PhD, from the Injury Control & Emergency Health Services Section, eloquently described the high quality of chiropractic care for low back pain and other injuries, for valid data documenting our efficacy, quoted the [Agency for Health Care Policy and Research] guidelines and other studies, and praised chiropractic colleges and ACA and ICA for their track record in maintaining agency membership in APHA.
>
> Minimal opposition was raised to the chiropractic section application, mostly in the form of concerns about chiropractic support of proven public health practices such as immunization and water fluoridation. Concern was also raised that a Chiropractic section should focus on rallying chiropractors' support for public health preventative programs; the need to monitor fringe practitioners and unscientific procedures was also mentioned. Opposition was voiced by John Muth, MD, MPH, from the Colorado affiliate, and from APHA President-elect E. Richard Brown, PhD. Mention was made frequently of an anti-vaccination letter filled with questionable references that had been published a few weeks prior in *The Nation's Health* by a self billed "DC-MPH homeopathic physician-public health educator" (who fortunately was determined not to be a member of ACA or ICA or APHA!). Dr. Victor Sidell spoke again in our defense, as did Alan I. Trachtenburg, MD MPH, chairman of Alternative and Complementary Health Practices SPIG [the renamed "Alternative Medicine" SPIG], and acting director of the Office of Alternative Medicine at [the National Institutes of Health].
>
> Dr. Haas expertly answered several concerns, and Dr. Baird ended the debate by calling for fair play, equal membership rights, and non-discrimination against a profession, pointing out to the Governing Council that the section application was in good order and that the chiropractic members were stronger in some areas than others but nevertheless in substantial compliance with the required criteria for being granted full section status.
>
> The application was voted upon and by an overwhelming majority the CHIROPRACTIC HEALTH CARE SECTION was established, becoming the first new section in three years, joining APHAs 24 other sections as a full-fledged partner with equity and parity with all other disciplines. It was noted that in its Centennial year, the Chiropractic profession had joined the other professions for public health.

Indeed, in the year chiropractic celebrated its hundredth birthday, it achieved equality in this setting.

The section's name was chosen by Dr. Rand Baird, and was—and remains—the only section with both the words "health" and "care" in it. As noted previously, connections made in years past had proven fortuitous. Both Dr. Sidell and Dr. Rodriguez-Trias as former APHA presidents provided critical support at the time of the application. Dr. Rodriguez-Trias voiced her support with these words:

> Over the years that the Chiropractic Forum has been actively involved in APHA activities, I have met with many of its leading members. I have been struck by their understanding and commitment to APHA's mission and goals. The Chiropractic Forum would make an excellent addition to the community of APHA sections. I hope that the Executive Board will add its support to the Forum's application when it comes before the Governing Council.

Dr. Haas became the first chairman of the new Chiropractic Health Care (CHC) section. He immediately appointed the other five chiropractors that had helped complete the application for section status to a committee to prepare a mission statement for the new section. Drs. Rand Baird, William Meeker, Robert Mootz, Michael Perillo, and Fred Colley, PhD went to work.

Because the new section had been created, chiropractic members continued to shift from the RH section to the CHC section. It was assumed that some chiropractors with DACBR (Diplomate, American Chiropractic Board of Radiology) credentials would remain in the RH section, but most chiropractors transferred. This was a blessing to the new CHC section, but did harm the RH section. RH section members and officers—many of whom were not chiropractors—deserve thanks for their support of the chiropractic section application. The RH section faced downgrading to SPIG status before chiropractors began joining the section in the early 1980s, and now did again as the chiropractors left. Chiropractic membership had temporarily breathed new life into the RH section, but the radiation protection members never revitalized recruitment from their own primary profession. Many of the RH leadership roles had been expertly filled by Drs. Rand Baird, John Pammer, Jr., Sharon Jaeger, Michael Loader, and Robin Canterbury, but an unfilled gap was created when they eventually left to join the new CHC section. In 1998, three years after chiropractic achieved its own section, the RH section would finally revert back to a SPIG after 34 years as a section. The low renewal rate of chiropractic members continued to plague the new CHC section. It was clear that to retain section status, the CHC section should strive to have 500 members in September 1998 when the official membership tally was taken by APHA. If there were not 500 members, section status would be endangered.

At the moment, though, chiropractors in APHA celebrated the fact that many years of hard work had paid off.

The CHC section was excited to work with the Podiatric Health, Vision Care, and RH sections, as well as with the Alternative and Complementary Health Practices (ACHP) SPIG on collaborative projects as a full APHA partner at last. The ACHP SPIG was growing rapidly and was very public with their support of the chiropractic section. Last, another important contact came into a position to help the profession: Fernando Trevino, PhD, MPH, Executive Director of APHA was elected president of WFPHA. The WFC would make its application to WHO in the next year, and WFPHA would offer its support with these words:

> The purpose of this letter is to offer the support of the World Federation of Public Health Associations (WFPHA) for the application of the World Federation of Chiropractic (WFC) for official relations with WHO. We are familiar with the WFC . . .
>
> Members of the chiropractic profession have been increasingly active in national public health associations. In 1995, after approximately ten years [sic] of collaborative work, the American Public Health Association created a separate chapter for chiropractic in recognition of the contribution of members of the profession to the activities of APHA. WFPHA is of the view that the WFC can be a significant resource in assisting the goals and activities of WHO.
>
> For these reasons, WFPHA gives its warm support to the present application.

Those "years of collaborative work" were beginning to bear fruit in 1995 and 1996 and the future seemed bright for chiropractic and public health. In 1996, chiropractors were serving in multiple roles at the national APHA level. The CHC section staffed its first booth at the APHA annual meeting under Dr. Michael Perillo's coordinating efforts. The section produced its mission statement, section information sheet, and booth description under the direction of Drs. Haas and Baird. The CHC section co-sponsored presentation sessions with at least five other groups at the annual meeting. For the first time, the CHC section presented its own awards for Distinguished Service and Accomplishments. These were given to Drs. Rand Baird, Karl Kranz, and Herbert Vear. The RH section gave awards of Distinguished Service to two chiropractors: Drs. Beverly Harger and Michael Loader. The new President-elect of APHA—Dr. Quentin Young, MPH—was an old hospital acquaintance of Dr. Baird and "pro-chiropractic." Despite continued poor renewal resulting in only 362 members remaining in the CHC section, these positive events demonstrated that chiropractic was fully engaged in APHA.

In 1997, Dr. Cheryl Hawk of Palmer College of Chiropractic facilitated another first for chiropractic in the APHA. Dr. Hawk arranged for Continuing Education credit for the chiropractic-sponsored education sessions, generating positive visibility. Additionally, the CHC section continued to coordinate presentation sessions with other groups. The CHC section was involved in many APHA projects, including work on the Strategic Plan and various task forces and initiatives. APHAs Executive Director, Dr. Mohammed Akhter, recognized Dr. Baird for his tremendous success in recruiting members to the APHA. Dr. Baird has recruited more members to the APHA than any other member in the history of the association. Chiropractic membership in the CHC section did mildly increase in 1997 to 430. However, by 1998, 500 total members were needed or the section could be threatened with dissolution.

In 1998, the section discussed several topics, including the ideal chiropractic public health curriculum that would be presented at the next ACC meeting and policy statements on immunization and fluoridation by APHA agency members ICA and ACA that seemed to contradict official APHA positions. The CHC section discussed submitting input to the "Healthy People 2010" goals, but found that FCER was already working on this. The group further noted a significant trend was emerging in that an increasing number of chiropractors were pursuing formal public health degrees. Section members hoped that this would help further unite chiropractic practitioners with public health practice. Despite the section's efforts, membership dropped below 300 in August 1995. Though recruitment of new members was exceptional, low renewal rates continued to plague the section.

Several significant events occurred in 1998. First, Dr. Mitchell Haas was elected to serve the APHA Intersectional Council as Chair-elect (and would serve as Chair in 2000–2001). This remains the highest elected position any chiropractor has held in the APHA. Due to a rule change, he would also receive an automatic seat on the Executive Board in 2000, which became the highest position ever filled by a chiropractor within the APHA. Second, a chiropractic-authored paper appeared in *AJPH* for the first time. Eric Hurwitz, DC, PhD, Ian Coulter, PhD, Alan H. Adams, DC, Barbara Genovese, MA, and Paul Shekelle, MD, PhD published "Use of Chiropractic Services from 1985 through 1991 in the United States and Canada" in the May 1998 issue. Other chiropractors served on APHA-level committees.

Last, as noted, the RH section was downgraded to a SPIG in 1998. By then all chiropractors had transferred to the CHC section.

In 1999, the ideal public health curriculum for teaching public health in chiropractic colleges was continued, and even received some attention in *The Nation's Health*. For the first time, other health care disciplines offered continuing education credit to their members who attended chiropractic sessions, a practice that would continue. Despite these accomplishments, membership in the section continued to struggle and was about 300 that year.

Dr. Michael Perillo received a Health Resources and Services Administration (HRSA) grant in 2000 to further the development of the ideal chiropractic public health curriculum. In 2001, that progress would be noted in a full article in *The Nation's Health*. Unfortunately, CHC section membership slipped under 300 in 2000, continuing the difficulty persistently faced by chiropractic within this venerable institution.

In 2001, because of his service as the Chair of the Intersectional Council, Dr. Haas sat on the APHA Executive Board. As such, he had the opportunity to preside at a session featuring U.S. Surgeon General David Satcher. That year, Dr. Haas was also elected by the Oregon Public Health Association to its seat on the Governing Council and its Executive Board, a historic first. The APHA officially recognized Dr. Baird for "Commitment, Dedication, & Outstanding Leadership." Significantly, Dr. Lisa Killinger, at the request of the APHA Executive Director, presided at a special session called "Faith, Terror, Hope, and Public Health: Exploring the Common Ground" at this post 9/11 annual meeting. Dr. Monica Smith co-authored an article to appear in *AJPH* this year, only the second article with chiropractic authorship in that journal. The APHA also announced that it would produce a special issue of *AJPH* in October 2002 on "Complementary and Alternative Medicine." Chiropractic was making amazing gains in the APHA and within public health.

Furthering those gains, the ACA declared its intention to develop a wellness model and increase involvement with APHA. *Dynamic Chiropractic* began a regular feature called "Chiropractic in the American Public Health Association" edited by Dr. Rand Baird that would ultimately feature articles by Drs. Rand Baird, Joseph Brimhall, Cheryl Hawk, John Hyland, Lisa Killinger, John Pammer, Jr., Monica Smith, and many others. Ironically, at this time of great achievement, chiropractic membership dipped to an all-time low of about 240. The CHC had now become the smallest section within APHA.

Membership fell to 215 in 2002. Somewhat shockingly, one member who had failed to perform duties on the Section Council for three years showed up at the annual meeting exhibit hall where he rented his own booth and promoted his own commercial venture! Several other members failed to attend or fulfill section duties. A rather biased article was published in the "Complementary and Alternative Medicine Issue (CAM)" of *AJPH* about chiropractic. In spite of these low moments, there were many bright spots for the CHC section in 2002. Dr. Michael Perillo presented the "Model Public Health Curriculum" for chiropractic colleges to the ACC Annual Meeting in New Orleans. Dr. Lisa Killinger successfully authored and obtained an APHA grant to sponsor activities promoting intersectional collaboration, including a multi-disciplinary health promotion booth at the annual meeting. This collaborative booth won second prize for exhibits at the annual APHA conference, the first time chiropractic received an award for APHA exhibition. Chiropractic members continued to serve on official APHA committees and Dr. Haas continued as a member of the Oregon Public Health Association's Executive Board. *AJPH* did publish two chiropractic-authored articles in the October CAM issue. A total of four chiropractic-authored articles had now appeared in that prestigious journal.

In 2003, several positive developments continued. The CHC section collaborated for the second time with the Vision Care, Podiatry, and Oral Health Sections to produce a mega-booth in the exhibit at the Annual Meeting, which was awarded a tie for first place for finest exhibit. Several thousand people saw the booth, including a U.S. Navy flight surgeon "seeking DCs in Hawaii to whom Navy patients could be referred." Dr. Haas continued in his positions on the Governing Council and on the Executive Board of the Oregon Public Health Association, and chiropractors continued to serve on committees of the APHA. Dr. Haas also was the co-author on an article published in *AJPH* in December, only the fifth chiropractic-authored article to appear in this prestigious journal. This year, because of changes within APHA regarding the declining value and status of Agency membership, most colleges let their agency status lapse and instead were supported under the Association of Chiropractic Colleges (ACC), which had established agency affiliation with the APHA. Dr. Baird and a delegation from

the WFC had an opportunity to attend the WHO World Health Assembly in Geneva, Switzerland. There he met with Drs. Georges Benjamin and Allen Jones, both of whom hold significant positions within both the APHA and WFPHA. Surprisingly, chiropractic membership in APHA remained small, despite these tremendous gains made by and on behalf of the profession through affiliation with this organization. The CHC section continued to be the smallest in APHA, with membership of about 270 in 2003.

In 2004, the ACA expressed interest in a public health column appearing in their new online publication scheduled to launch in 2005. This would significantly complement the ongoing efforts of *Dynamic Chiropractic*, which has provided column space for articles on any aspect of "Chiropractic in the American Public Health Association" since 2001. More chiropractors presented papers in multidisciplinary settings at the annual meeting, an encouraging trend. The CHC section cosponsored another mega-booth this year in the exhibit hall. Despite these opportunities to function as equals in a multidisciplinary setting, membership in the CHC section remained low, below 235 in 2004. The section membership chair had not been fulfilling duties, and a new one was appointed for 2005.

There were positive developments in this active section. The Public Health Committee of the WFC developed two anti-tobacco public health posters that were distributed to all chiropractors through the efforts of *Dynamic Chiropractic* and many chiropractic organization cosponsors. Dr. Cheryl Hawk worked with many of these sponsoring agencies to co-author a published field study on WFCs anti-tobacco campaign. It was noted that increased emphasis was being given to Healthy People 2010 and related current public health information by the CCE and on National Board exams. It was proposed that chiropractic colleges should consider subsidizing APHA membership dues at least for lead public health instructors on their faculty. The section also announced plans in 2005 to create a national registry of chiropractic public health instructors. The section honored Dr. Baird for 25 years of work (1979–2004) within the APHA and for promoting chiropractic and public health. The CHC section was moving actively into the future.

The year 2005 marked the tenth anniversary of the CHC section and over 20 years of chiropractic within the APHA. Achievements this year included cosponsoring a session at the APHA annual meeting with the Vision Care Section and cosponsoring a mega-booth for the fourth time with Vision Care, Podiatry, and the Oral Health sections. The CHC section reviewed the "Straighten Up and Move" program presented by Dr. Ron Kirk of Life Chiropractic College. The ACA began publishing a public health article in its online publication. In 2005, the sixth chiropractic-authored article appeared in the *AJPH*, this one with Eric Hurwitz, DC, PhD as lead author. Dr. Paul Dougherty of New York Chiropractic College introduced Dr. Baird to public health and chiropractic student Jonathon Egan at the conclusion of the CHC section business meeting. There, Dr. Baird extended the invitation to Dr. Egan to commemorate the 10th anniversary of the CHC section by chronicling the history of chiropractic within the APHA over the last two decades—the inspiration for this article. Also at this annual meeting, the APHA Executive Director and Membership Committee recognized Dr. Baird for his efforts over many years. Further, CHC section chair Dr. John Hyland and Drs. Mitchell Haas and Rand Baird were honored at the APHA awards ceremony in recognition of chiropractic's ten year anniversary as an official section.

Again, in spite of all these positive events, section membership remained an obstacle and concern. The CHC section was the second smallest section in the APHA in 2005, exhibiting no real growth over the past several years and retaining membership just above 200. A new membership chair in 2005 provided hope that the section would again grow. *Dynamic Chiropractic* again showed willingness to support chiropractic and public health by generously donating column space for a membership drive in 2006.

To help enhance membership and connections with chiropractic campuses, the CHC section sought to complete a registry of all public health instructors at chiropractic colleges. While this was not completed in 2005, the CHC section recommitted to its completion in 2006. It was again noted that chiropractic college Presidents should subsidize APHA membership dues for all lead public health instructors on chiropractic campuses.

Chiropractic efforts within APHA will continue. In 2006, several leaders of the CHC section met again at the Association of Chiropractic Colleges-Research Agenda Conference (ACC-RAC) in Washington, DC and will continue to explore ways to enhance the role of chiropractic in public health, including the promotion of

membership in APHA. Meanwhile, the accomplishments of the past two decades should be recognized and celebrated. Chiropractic went from pariah, to participant, to full parity over 25 years of contact and cooperation within APHA.

This example could serve as a model for chiropractic engagement within other political and professional organizations. By collaborating with other professionals and developing relationships of trust, chiropractic has become a respected partner on both the national and global stages. All chiropractors owe a debt of gratitude to those self-sacrificing volunteers who demonstrated determination, perseverance, and persistence while striving for the greater good of their profession over many years, creating a role for chiropractic within the APHA. Their work opened the way for chiropractic in many venues, including state agencies and as affiliate members of WHO. The past has been bright. The present is full of potential. Chiropractors can now take an active role in the local, national, and global public health effort, fully embracing a future with chiropractic and public health together.

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CHAPTER 2

Basic Concepts in Public Health

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CHAPTER OUTLINE

DEFINITIONS IN PUBLIC HEALTH

Public health, as defined by C. E. A. Winslow, a leading figure in the history of public health, is

> the science and art of preventing disease, prolonging life, and promoting health and efficiency through organized community efforts for the sanitation of the environment, the control of community infections, the education of the individual in personal health, the organization of medical and nursing services for the early diagnosis and preventive treatment of disease, and the development of the social machinery which will ensure to every individual in the community a standard of living adequate for the maintenance or improvement of health....[1]

This was not a bad definition for 1920. Today the American Public Health Association (APHA) states that public health is the practice of preventing disease and promoting good health within groups of people, from small communities to entire countries.[2] APHA further states it includes health professionals from many fields working together with the common purpose of protecting the health of a population.

The goal of any community, or health care provider for that matter, should be to prolong the number of years of healthy life of the population it represents or cares for. With that goal in mind, people, social infrastructure, government aid to those most in need, and investigation of disease outbreaks may all play a role in the public's health. Public health uses the trends and occurrences of disease in our populations and population subsets to infer the *risk* of disease for individuals. To some degree, the basis of risk or a *risk factor* (making one more susceptible to a disease) takes its origin loosely from the work of Koch. Koch's postulates looked

at diseases caused by living organisms and stated that basically the following four relationships must occur regarding causes of disease:

1. One must observe the [causative] organism in every case of the disease.
2. It must be able to be grown in a pure culture.
3. The pure culture must, when inoculated into a susceptible host animal, reproduce the disease.
4. The microorganism must be observed in, and recovered from, the experimentally diseased animal.[3]

Koch's concepts would be great if they could be applied to every disease state, but how can one apply these to chronic diseases that take years to develop and perhaps are due to multiple causes or risks? Unfortunately, they can't. This brings up the concept of risk factors. *Risk factors* are those exposures or causal agents that make one more likely to suffer a disease or health problem. Although a risk factor may cause a disease if present, it may not actually be the true cause. The presence of other factors may be necessary to cause the disease to occur. One can use tobacco as an example of how one risk factor can predispose a person to several diseases at one time. Friis and Sellers point out that risk factors have three prerequisites.[3]

1. The frequency of the disease varies by category or value of the factor. Example: Using smoking and lung cancer, they state the relationship between smoking and cancer—the more one smokes, the greater the *risk* of cancer.
2. The risk factor must precede the onset of the disease. Example: Using the same lung cancer and smoking issue, they state if a smoker started smoking after developing lung cancer, it would be wrong to label smoking the cause of disease.
3. The observed association must not be due to any source of error. There are always points at which errors may be introduced in trying to assess causes of disease. Examples: Errors can occur in the selection of the study participants, in the measure of exposure and disease, and, of course, in statistical analysis.

Exposure to a risk factor may occur due to actions or behaviors one adheres to or may simply be inherent to the individual due to the genetic cards they have been dealt. For example, we know that prostate cancer is always going to occur in males and cancer of the cervix in females. This demonstrates that simply being born into one gender category or the other increases one's risk for some diseases. Race, socioeconomic grouping, nationality, ethnicity, and where one lives in proximity to the equator may be a risk factor for certain diseases. Hypertension is more prevalent in Blacks than Whites; that is, there are proportionally more *existing cases* of the disease among Blacks than Whites, which is the definition of the term *prevalence*. Living in an area of the country where sun exposure is greater more days of the year may increase risks of skin cancer, and living where there are fewer days of sun could reduce the amount of vitamin D one has circulating in the blood, which is now thought to increase risks for a host of diseases.[4] Generally, it is felt that there is a "web of causation" for most chronic diseases such that few instances exist where a single risk factor causes a disease to occur.

Epidemics occur when there are a large number of cases of a disease that are out of proportion with what is normally expected to be seen for that time, place, or group. The actual number may vary depending on the type of disease or the population that has been exposed. For instance, in a country where there is a high prevalence of malaria, a disease caused by a parasite in the blood carried by mosquitoes, a few extra cases may be meaningless, but in Panama City Beach, Florida, during Spring Break, even a half-dozen cases would sound an alarm. That is because even in Florida, malaria is not seen as an *endemic* disease; that is, a disease that is constantly present in the community or population. Unfortunately, diseases like human immunodeficiency virus or acquired immune deficiency syndrome (HIV/AIDS), influenza, hepatitis, and others are considered *endemic* in the United States.

Among those diseases endemic in a society, occasionally there are dramatic spikes in the numbers that are higher than those expected to be seen in the community or region. This is known as an *outbreak*. Any occurrence of an endemic disease that is out of proportion to what is expected may be seen as an outbreak. Certainly, an increase in a disease occurrence that is rarely seen or thought to be eradicated would also constitute an outbreak, and even one case of the latter may signal serious public health concerns. The U.S. Centers for Disease Control and Prevention (CDC) tracks thousands of outbreaks each year in the United States and abroad.[5] For more information on outbreak investigations, go to http://www.cdc.gov.

Terms Used in Public Health Reporting

Numerous terms are used to describe public health events, risk levels, and causes of disease. Among the more common are *morbidity, mortality, prevalence,* and *incidence*. *Morbidity* is the number of people suffering from a

disease at a given time. It is related to illness. *Mortality* is the number of people who have died from a disease.

The two most common measures of disease in populations are prevalence and incidence. Sometimes both terms are used in the description of a disease or disease outbreak. *Prevalence*, which has already been mentioned, is the number of people who have a disease at a given time; that is, the number currently suffering from the disease or disorder. *Incidence*, on the other hand, is the number of new cases of a disease. One may hear a news report of the *incidence rates* of a disease, such as influenza, being higher than usual for the year. This indicates the number of new cases is higher than what is typically expected, whereas a report indicating increased *prevalence* would mean the number of existing cases is higher.

Epidemiology is the science that looks at the relationships between diseases occurring in populations and groups, typically in an attempt to reduce risks and "compress morbidity" into the last years of the populations' life span. *Life span* is the limit of natural life such that through all supports and efforts one has lived as long as is possible. *Life expectancy* means something different, in that this term applies to the average length of life one may live based on gender, race, where one lives, and so on. Public health scientists and epidemiologists feel that the current life expectancy is not equal to the possible life span; that is, we don't live as long as we could live due to unnecessary risks that are taken and other factors that are typically controllable through behavior, lifestyle, and environmental changes. In the United States, overall life expectancy is about 78 years, although women typically live longer than men. Currently, the life expectancy of women in the United States is about 80 years and for men, 75.[6]

Causation and Sir Austin Bradford Hill's Criteria

Causation or causal factors in the investigation of a disease occurrence or outbreak can be difficult to establish. After all, not all diseases are associated with a known exposure to a risk factor, nor do all diseases manifest themselves shortly after exposure to even a known risk factor. For instance, it is well established that there is an association between smoking tobacco products and lung cancer. But how long does it take to get cancer? Cancer in general has what is known as a long *latency period*; that is, from the time one is exposed to a substance known to cause cancer, called a *carcinogen*, sometimes it is years before one actually develops the disease. During that time, multiple factors may come into play that could affect the individual's risks.

In the 1960s, the link between smoking and cancer was reported by the U.S. Surgeon General in a report titled, *Smoking and Health, Report of the Advisory Committee to the Surgeon General of the Public Health Service*.[7] Later, perhaps the most noted acknowledgment of this report came from Sir Austin Bradford Hill, a former professor of statistics at the University of London. In an address to the Occupational Medicine Section of the Royal Society of Medicine in 1965, Hill gave a speech in which he outlined the criteria he suggested were essential when trying to determine causation. He had derived much of his criteria from the report of the U.S. Surgeon General. Rather than fulfill Koch's criteria, Hill stated,

> With the aims of occupational, and almost synonymously preventive medicine in mind the decisive question is whether the frequency of the undesirable event B will be influenced by a change in the environmental feature A. How such a change exerts that influence may call for a great deal of research. However, before deducing "causation" and taking action we shall not invariably have to sit around awaiting the results of that research. The whole chain may have to be unraveled or a few links may suffice. It will depend upon the circumstances.[8]

From that point he defined the following nine issues that are relevant in public health when identifying causation:

1. *Strength of association:* Hill stated that, based on observation, in the 18th century Percival Pott noted the mortality rates from scrotal cancer of chimney sweeps in London to be 200 times that of those not exposed to the tar and mineral oils from that occupation. Hill also cited smoking and lung cancer and the knowledge that the more cigarettes smoked, the greater the incidence rates of lung cancer. He felt a strong association was less likely to be from errors in calculation or assessment of risks.
2. *Consistency of the observed association:* That is, has the same association been observed in more than one place by different persons at different times? Hill noted the U.S. Surgeon General's 1964 report on smoking and lung cancer had more than 30 studies linking smoking with an increased risk of cancer.
3. *Specificity:* If an association were to be noted in specific workers and limited to specific sites and specific types of diseases, there would also be a strong argument in favor of causation.

Hill suggested that conclusions could perhaps be drawn with less hesitation where strong specificity existed; with less specificity, the opposite would be true.

4. *Temporality:* Regarding time and association, Hill asked, "Which is the cart and which the horse?" Did a particular diet lead to a disease or do early stages of a disease cause one to start consuming a different diet? The exposure factor, therefore, should come before onset of disease.
5. *Biologic gradient:* Also known as dose–response. That is, with cigarettes as an example, scientists knew that the more one smoked, the greater the risks were for developing cancer. The higher the "dose" of tobacco consumed on a regular basis, the higher the "response" or risk of cancer. Hill also noted that a biologic gradient was not always present, but should be sought nevertheless.
6. *Plausibility:* It helps if the suspected causation is biologically plausible; however, he cautioned that what is thought to be implausible today may be more understood tomorrow and that plausibility was in relation to the scientific knowledge of the day.
7. *Coherence:* Is there coherence of the explanation regarding the known facts of the day? That is, the cause and effect data should not seriously conflict with the science of the day regarding the natural history and biology of the disease. He noted that lung cancer rates in smokers had increased as smoking as a habit had increased, and this was a coherent explanation of the increase in lung cancer incidence during that time.
8. *Experiment:* Hill said it was occasionally possible to observe a natural experiment in the works. This is simply the observation of some disease phenomenon and then some preventive action taken that results in a reversal of that phenomenon. A strong association could be noted if a preventive effort resulted in a decrease in frequency of the disease.
9. *Analogy:* Hill stated that in some cases a similar effect might be observed in a similar situation that could enhance the association. He used the drug thalidomide and the disease rubella as causes of birth defects to demonstrate that because these could cause such increased risks, it would make sense that other drugs or diseases could increase the risk of birth defects as well. Looking for a similar existing analogy could produce a stronger association if one were to be discovered in a new disease investigation.

Generally, it is felt that all of these criteria will not be seen together for any one assessment of causation, but the more that are present, the stronger the chance there is an association. Hill concluded that all scientific work was incomplete and liable to be upset by new scientific knowledge. However, his concepts are taught in every public health and epidemiology course to this day.

The reader should be reminded that in public health, studies are performed using populations and not individuals. At times there is a tendency to suggest that a risk factor noted within a population or large group is automatically assumed for an individual who may live within that group. To suggest that, for example, a person living in a city where there is a high incidence of cancer from smoking is at greater risk for lung cancer would be inappropriate. This person may be a nonsmoker, and therefore would not be at increased risk from smoking at all. The tendency to overlay a risk from population-based studies onto the individual is referred to as *ecologic fallacy*.

ASSESSMENT OF RISK AND OCCURRENCE OF DISEASE

When looking at the occurrence of disease or risks for disease, scientists in public health often look at *rates*. Rates are just frequencies of disease. As previously described, the *incidence rate* is the number of new cases of a disease, typically during a specific time period in a population. Incidence is a measure of risk for developing the disease. The incidence rate is typically defined per 1000 or even per 10,000 people. This would most appropriately be based on the population size one is investigating. The incidence rate is calculated by taking the number of new cases of a disease occurring in a population of interest during a specified time and dividing it by the number of persons at risk of developing the disease during that time per 1000, or perhaps 10,000 or more. Those in the denominator are those in the population who could become a new case in the population being assessed. So back to the example of diseases within gender. If we were to assess potential new cases of cervical cancer, we would definitely not include males in the equation, even though there are surely males in the population being studied. Simply put, you can't have the risk for disease in an organ you don't possess!

Measures of incidence often include a period of time that is of interest. When this is done, the definition is that of *cumulative incidence*. One could calculate the

number of new cases reported in a week, a month, a year, 5 years, and so on. It is up to the person calculating to decide what is most logical time period based on the disease being studied. Rapidly developing infectious disease rates may best be calculated in days, whereas chronic diseases that take years to develop would perhaps be best evaluated over several years.

Prevalence is also reported, but is really a proportion of those affected by a disease at a given time. So the calculation for this assessment is the number of affected persons present in a population at a point in time divided by the number of persons in the population at that time. This also can be calculated per 100, 1000, or more. Occasionally it is better to assess prevalence over a longer period of time, such as years. This creates two types of prevalence—*point prevalence* is the number of cases present at a certain time, such as in the previous example, and *period prevalence* is how many cases there were in a population over perhaps the last year or 5 years. Sometimes *lifetime prevalence* is assessed. For instance, the lifetime prevalence of lower back pain is near 80%; that is, about 80% of people in the United States will suffer from lower back pain at some point in their life. In contrast, how many people in the United States have lower back pain right now is an example of *point prevalence*, which is generally what is reported. And finally, how many have suffered lower back pain in the last year is an example of *period prevalence*. Note that this calculation does not provide evidence of when the disease started, nor does it help determine risk. People in the group assessed for prevalence may have had varying durations of disease and the calculation does not define new cases, so if you want to determine risk you must calculate incidence instead.

Prevalence of a disease is usually unsteady. For example, when a cure for a disease occurs, prevalence tends to be lower. When treatment for a disease prolongs life, however, prevalence may actually go up because more people are living longer with the disease. In essence, prevalence goes up if the death rate goes down in a treatable disease that is not cured. Some cancers, diabetes, and even HIV are examples of this phenomenon over the past several years.

Risk, when calculated, is a statement regarding the chance an individual will develop a disease over a specific period of time. Risk is calculated with a range between 0 and 1. Recall one needs a time frame as well. With people moving into and out of an area where an assessment is made over time, it becomes difficult to know the exact number of people being assessed. For example, what about a person who moves out of the area being assessed and then develops the disease? The opposite may also occur. This is why rates are used to determine an indication of risk in some cases. However, they should be used only when the rate of a disease is fairly constant and the chance of losing people from the population or follow-up time frame is relatively low.

Rates Reported in Public Health

There all sorts of rates thrown around in public health. Many are referred to as *crude rates*. These are the summaries of the numbers of actual situations occurring in a population over a given time. Death rates, infant mortality rates, and birth rates are examples of crude rates. Sometimes these rates are adjusted for race, age, geographic region, or socioeconomic status (SES), to name a few. These adjustments give a clearer picture of risk in many cases, based on the variables mentioned above. A good example of lower and higher SES groupings is the delineation between death rates or infant mortality rates in the lower SES groupings compared to higher groupings. These rates are known to be higher in lower SES categories, so this makes a statement about risks in that group versus in wealthier groups of a society. This information can then be used to plan the delivery of health services, health care, and even processes for health education campaigns.

Another example of a crude rate is the *crude birth rate*. This is the number of live births during a specific period of time, such as a calendar year, per resident population during the midpoint of that year, typically expressed as rate per 1000. The population of the United States is estimated at the midyear point, and that is the number used in the calculation. The crude birth rate is used to measure the population and for comparison among countries of the world. Infant mortality rates are also a measure of the health of a nation and are often used to compare countries when keeping score of how effective a health care system is for a population. Unfortunately, the United States ranks lower than many industrialized nations when it comes to infant mortality rates, indicating that many other countries do a better job in this area. Specific adjusted rates broken down by race categories and socioeconomic groups demonstrate existing disparities within the United States when it comes to how well a newborn will fare.

MEASURING FOR CAUSATION AND RISK ASSESSMENT

To determine causation, scientists must measure differences between groups. A typical measurement is to discern risks regarding the frequency of a disease by comparing a

Table 2-1 The 2 × 2 Contingency Table

		Disease Present: YES	Disease Present: NO	Totals
Risk Factor Present	YES	A	B	A + B
	NO	C	D	C + D
	Totals	A + C	B + D	A + B + C + D

A = those with the risk factor and with the disease
B = those with the risk factor and not the disease
C = those without the risk factor but with the disease
D = those without the risk factor and not the disease

Therefore;

"A + B" represents everyone with the risk factor.
"C + D" represents everyone without the risk factor.
"A + C" represents everyone with the disease.
"B + D" represents everyone without the disease.
"A + B + C + D" represents everyone in the study population.

group that has been exposed to a risk factor and a group that is unexposed. Examples of exposures include a known infectious agent, a vitamin that one group gets and another group does not get adequate amounts of, exposure to an education intervention, or a drug. Risk between the exposed and unexposed groups is typically compared through the use of a 2 × 2 contingency table. See **Table 2-1**.

Based on the table, one can mathematically assess risk and odds. Essentially, the risk of getting the disease among those exposed to the risk factor becomes the simple equation A/(A + B). The odds of getting the disease among the exposed is A/B. An example often used is the risk of 1 person getting a disease out of a group of 100 in, say, 1 year. In that case, the risk is 1/100 or 0.0100. The odds of getting the disease, however, become 1:99 or 0.0101. An *odds ratio* (OR) then can be calculated by dividing the odds of exposure in those with the disease by the odds of exposure in those without the disease. Or, as follows:

$$OR = (A/C)/(B/C)$$

$$OR = AD/BC$$

Because this is a ratio, the range will usually be from zero to infinity, but can actually calculate out to be below zero and rarely goes above 10. This calculation will result from a cross-tabulation, so if the odds of disease are exactly the same in both groups, the odds ratio will be 1.0. In this case, there is no risk for the exposed that is greater than for the unexposed. By that same token, an odds ratio of 1.5 indicates a 50% greater risk for the exposed; an odds ratio of less than zero indicates a protective effect in the exposed group. As a rule of thumb, the exposed group is usually placed in the numerator.

It may sound impossible to see an exposure reduce risks, but occasionally exposure to something does appear to reduce the risk of certain disorders. Recent studies on coffee are an example in that those who drank large amounts of coffee (exposure group) had less risk of type 2 diabetes or problems with insulin regulation.[9,10] In addition, the example of exposing a person to an education campaign to increase screening for skin cancer or breast cancer would hopefully result in a lower risk for those in the education group versus the group who does not get exposed to the education.

RISK DIFFERENCE

Sometimes it is important to determine the difference in risk between two groups. Usually this will be the difference between the risk in an exposed group versus the risk in an unexposed group. This is called the *risk difference*. Occasionally it is called the *attributable risk* because it assesses the risk that is attributed to the exposure factor or risk factor. The risk difference or attributable risk (AR) can be defined as

$$AR = [A/(A + B)] - [C/(C + D)]$$

$$= \text{Risk among the exposed} - \text{Risk among the unexposed}$$

Note that the difference is taken, so subtraction is the proper mathematical operation. When the risk is the same for the exposed as it is for the unexposed the calculation will derive a difference of 0.0, meaning that the risk factor seemed to have no effect on those who were in the exposed group. If the exposure factor produces a positive difference, there is greater risk of disease among the exposed. If it produces a difference of less than zero, there is a reduction in the risk associated with those exposed to the risk factor. One example of a reduction in risk would be those exposed to folic acid having a lower risk of neural tube defects than those not exposed.

RISK RATIO

A *risk ratio* is another measure common to the science of public health. This is the ratio of the risk in the exposed group compared to the ratio of the risk in those who are unexposed. Sometimes it is called the *relative risk*. If the risks are the same in both groups, the risk ratio will equal 1. The greater the ratio, the more the risk is for the exposed. Smaller numbers indicate less risk or protective effects among those exposed.

The calculation for risk ratio (RR) is as follows:

$$RR = [A/(A + B)]/[C/(C + D)]$$

$$= \text{Risk in the exposed/Risk in the unexposed}$$

Later chapters of the text will cover the types of studies that use these statistics in detail and provide a better understanding of the applications of these measurements of risks. Just remember that the goal is to determine the risks to a population, so that methods of disease prevention and health promotion may be applied in order to reduce those risks in the community or among the group being investigated.

PREVENTION

The outcome of any investigation on risk is to determine what may be done in order to reduce those health risks within the population. Public health scientists and health care providers should focus efforts on prevention, when this is determined to be possible. As discussed in Chapter 1, prevention has typically been defined with three levels—primary, secondary, and tertiary. In the case of *primary prevention*, the efforts are focused on keeping the healthy in a healthy state; that is, true prevention of disease. Recall that a goal among public health professionals is to compress morbidity so that more years of healthy life may be enjoyed, with the morbidity, which will one day come for all persons, being reduced to the last part of a person's natural life span.

Primary prevention employs what are often referred to as *upstream approaches*. This simply means that one looks to the actual cause of disease rather than looking on down the line after a disease has manifested itself within a population. The latter are referred to as *downstream approaches*. An example of an upstream or primary preventive effort is to get people to partake in regular exercise and a healthy diet so they don't become overweight or obese, rather than having to encourage a weight loss program or a surgical intervention once a person or group is known to be overweight or obese (a downstream approach).

Secondary prevention is the next level of interest. This indicates a problem has already occurred. Perhaps a person has discovered that they have higher than normal blood pressure. They know their blood pressure is high and they take action to reduce it by changing their diet and starting an exercise program. This is an effort to thwart the damages of a disease before it causes permanent changes that can't be undone. Although this is not primary prevention, it is a necessary part of health care delivery in the United States. Unfortunately, a lot of money is spent on this level of prevention and on the third and final level, *tertiary prevention*. In this case, a person has suffered from a disease that has caused some damage to his or her health. Maybe they have suffered from a heart attack or stroke and have been told by their doctor that they must change their ways or they will suffer further consequences. In that case, the efforts they put forth from this point on constitute tertiary prevention—those efforts to prevent the problem from getting worse or ending their life prematurely if this is possible. Clearly, there is a need to focus as much effort as possible on primary prevention. To some, this represents what is known as health education and health promotion.

Figure 2-1 indicates where treatment falls within the levels of prevention.

Health education is the delivery of any information that is conducive to health. *Health promotion* takes this a step further and may include any social supports, laws, or policy changes that may facilitate efforts conducive to health. A health education campaign may be aimed at children to try to prevent them from smoking. Health promotion efforts have banned the sale of cigarettes to minors in an effort to facilitate this education process. These definitions bring up two additional definitions that are used when speaking of preventive methods in a population: micro issues and macro issues. *Micro issues* related to promoting health include those that are germane to the individual. The genetic make-up of the individual; their knowledge, attitudes, or beliefs; and even their past medical history can be considered as micro issues. A doctor who tells his or her teenage patient not to take up smoking is following a micro approach.

Macro issues are the opposite. They involve everything environmental and social that may influence how people behave. Social networks, policies, laws, and the occupational culture one works in all influence health indirectly but must be considered when planning any preventive

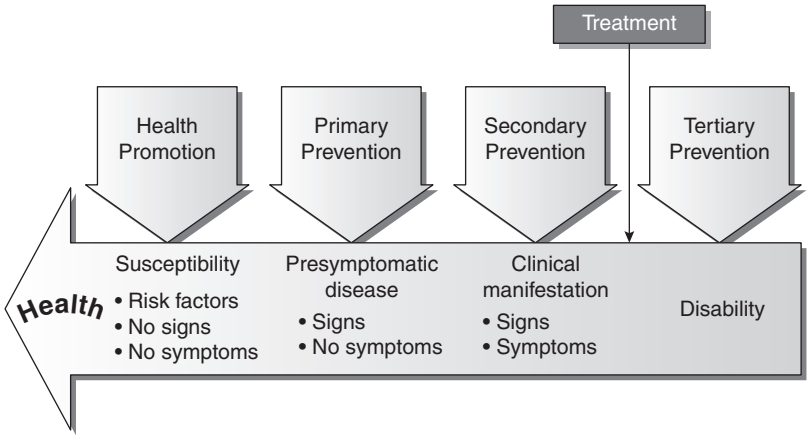

Figure 2-1 Phases of prevention.
Source: Courtesy of Dr. Cheryl Hawk, DC, PhD.

effort for a population. After all, not every community has the same social issues or cultural norms, and each of these may play a part in whether a population is healthy or unhealthy. A city or county law banning smoking in public places is an example of a macro approach to health promotion.

The Mission of Healthy People in the Prevention of Disease

In the late 1970s, the U.S. government worked to facilitate a plan to help our nation reach a healthier status. This project was known as Healthy People.[11] The original goals of this initiative were to be achieved by the year 2000. Unfortunately, they were not met. However, they have had an impact on how health care, public health, and health professionals as individuals work toward helping our population reach its health goals. Healthy People 2010 was the next permutation of the Healthy People project and in 2010, Healthy People 2020.

Healthy People 2010[12] had two broad goals to: (1) increase the quality and years of healthy life, and (2) eliminate health disparities. In addition to these overreaching goals, this public health directive lists 28 focus areas and 10 leading health indicators. These are listed in **Tables 2-2** and **2-3**, respectively. As can be seen by looking at these focus areas and leading health indices, all health care providers, including chiropractors, have a role to play in preventive care. Among the areas where chiropractors could clearly involve themselves are helping patients increase levels of physical activity, and addressing overweight and obesity, tobacco use, and injury prevention. Each constitutes an area of special concern because they are associated with increased incidence of chronic spine disease.[13–15]

Table 2-2 Twenty-Eight Focus Areas of Healthy People 2010 (listed alphabetically)

Access to quality health services
Arthritis, osteoporosis, and chronic back conditions
Cancer
Chronic kidney disease
Diabetes
Disability and secondary conditions
Educational and community-based programs
Environmental health
Family planning
Food safety
Health communication
Heart disease and stroke
Human immunodeficiency virus
Immunization and infectious diseases
Injury and violence prevention
Maternal, infant, and child health
Medical product safety
Mental health and mental disorders
Nutrition and overweight
Occupational safety and health
Oral health
Physical activity and fitness
Public health infrastructure
Respiratory diseases
Sexually transmitted diseases
Substance abuse
Tobacco use
Vision and hearing

Table 2-3 Leading Health Indicators from Healthy People 2010

1. Physical activity
2. Overweight and obesity
3. Tobacco use
4. Substance abuse
5. Responsible sexual behavior
6. Mental health
7. Injury and violence
8. Environmental quality
9. Immunization
10. Access to health care

Screening

Screening patients for disease risks can be as simple as asking them questions on patient intake forms; for instance, asking if they use tobacco products, and if so for how long and how often, screens for risk of diseases associated with smoking and other tobacco usage. Patient history may reveal familial tendencies toward cardiovascular disease or cancer for which preventive efforts are known to be effective, especially with lifestyle modification and changes in behaviors. In addition, proper use of screening tests from simple blood pressure checks or height and weight assessments to blood lipid and blood sugar can be done in many chiropractic offices or ordered as a routine or where indicated. Certainly, screening for scoliosis and other chronic musculoskeletal conditions would be warranted in chiropractic practices as well.

Screening should be a routine procedure for all clinicians. Although some types of screening may be more in line with family practice or through a primary care medical physician, all health care providers should do their part to address the modifiable risk factors for early morbidity, mortality, and disability. The U.S. Preventative Services Taskforce has a guide to recommended preventive screenings that addresses topics from cancer and cardiovascular disease to mental health, injury and violence, and musculoskeletal and most other conditions where screening may be indicated.[16] This guide lists the evidence base for various screening tools or procedures and gives the clinician an idea of what should be done and what may be unwarranted based on the latest scientific information. The guide is available at http://www.ahrq.gov/clinic/uspstf/uspstopics.htm.

COUNSELING PATIENTS ON BEHAVIOR CHANGE

Typically, for clinicians the opportunity to have an effect on lifestyle or behavior modification occurs in the micro setting described earlier. This deals with those traits the individual is responsible for. Although the micro area may involve genetics or even past medical history issues, it mainly involves the knowledge, attitudes, and belief systems of patients. Several theoretical models exist that can assist health care providers when it comes to better understanding how behavior will or will not change. The old adage regarding health behavior that "knowledge is necessary but not sufficient" is very true. After all, every smoker can read on a pack of cigarettes that the behavior may kill them. Simply stating the facts to a patient will not typically result in behavior change. They may already be aware that a change is needed but may not be ready or willing to make a change. When to counsel and how to work with patients, people, and populations on health behavior change is aided by an understanding of health behavioral theory models. Some of the more commonly used models are described in the following sections.

Stages of Change

In the field of health education and health promotion, a noted theoretical model of behavior change is the *Transtheoretical Stages of Change model*, developed by Prochaska and DiClemente.[17] This model has been employed for years to better evaluate an individual's level of readiness for a change in behavior. The model may be best utilized in clinical practice for identifying those people most likely to accept a behavior change message and to make an attempt at follow-through.

The model has five stages of susceptibility for change. People don't necessarily move through them in a linear fashion but may go back and forth among the stages as they struggle to change their behavior over time.

First, a person who has no intention, desire, or knowledge of a need to change is referred to as being in the *precontemplation* stage. They may simply be unaware of a need for change or they may know of the need but have no interest or intention of making any changes within the next 6 months. The next stage within the model is of course *contemplation*. People in this stage may be contemplating a change within the next 6 months or so. This could be a smoker who knows they need to quit and is waiting until New Year's Day to make it a resolution or perhaps waiting for

the Great American Smokeout marketed by the American Lung Association.

Once a person reaches the *preparation* stage, they are actually deciding on what steps to take in order to reach the next level, which is referred to as the *action* stage. Those in the preparation stage are often gathering information and perhaps asking others what they should do next. Some kind of action is typically being taken at some point, and this means the individual has done something constructive toward changing their behavior. Once a change has been made and the person has held on to the new behavior for 6 months they are said to be in the final stage, called *maintenance*.

It is easy to see that with the Stages of Change model, one would counsel a patient differently based on what stage they are in. If they are a precontemplator one would want to try and move them into at least contemplation. This may involve bringing to their attention a known risk factor they were previously unaware they had. In the case of smoking, they know it is bad for their health but maybe no health care provider has ever told them they should quit. Current studies on smoking cessation suggest that only a minority of patients have been told by their doctor they should quit.[18–20] Information should be given such that every precontemplator has the opportunity to move to the contemplation phase. Of course, the contemplator should be encouraged and given resources that will allow them to move on to the preparation or action stages of the model. The goal is to move the patient in the direction of change. Once in the maintenance stage, the provider can focus on ways to help the person maintain the new, healthy behavior and not succumb to relapse. Having patients list action steps and think of previous episodes where they were unsuccessful and how they could act differently in their current situation may be helpful as well.

It should be noted that groups such as the American Lung Association, American Heart Association, U.S. Centers for Disease Control and Prevention, and others have information that is actually stage-specific for helping patients change behavior. Again, the goal is to identify the stage the patient is in and focus the appropriate level of action on them, based on their susceptibility toward receiving advice on behavior change. This model has been utilized extensively in health promotion research and has been shown to be effective in assisting the counseling and education process at the micro level. **Table 2-4** lists the Stages of Change and some ideas on implementing them in clinical practice.

Health Belief Model

Another model that has been in use for many years is the *Health Belief Model (HBM)*.[21] First utilized by the U.S. Public Health Service to better understand who may be most likely to get a tuberculosis screening, HBM has now been used in many different campaigns to get people to take action. It is perhaps best used to get a patient or person in general to take a single specific action, such as get a mammogram or other screening test. The model has six basic constructs, as follows.

The first of the constructs is called *perceived susceptibility*. In other words, if a health care provider wants an individual to take a certain screening test, does that individual even think they are susceptible to the disease being screened for? If not, they are less likely to see the

Table 2-4 Counseling Options for the Stages of Change

Stage of Change	Counseling Options
Precontemplation	Advise patient on risk factors that need to be changed (increase awareness). Provide personalized information and cue them to take action. Attempt to move them toward *contemplation* or *preparation*.
Contemplation	Motivate and encourage patient to make changes and mark a chart to follow up with them on their next visit. Attempt to move them toward *preparation* or *action*.
Preparation	Help set action steps and achievable goals for patient. Mark chart to follow up. Attempt to move toward *action*.
Action	Behavior has changed. Assist with problems and social support, reinforce new behavior, and help prevent relapse. Attempt to move toward *maintenance*. Provide stay the course messages.
Maintenance	Help avoid relapses, assist with coping, and reinforce new behavior. Reward or praise whenever possible. Provide stay the course messages.

test as necessary and important enough to go through with. The next consideration in the model is whether the person will deem the condition severe enough that they may need screening. This construct is called *perceived severity*. Dreaded diseases tend to carry more perceived severity than diseases that are rarer or more obscure. The next two things to take into account are *perceived benefits* and *barriers*. If there are perceived barriers to having a test done or going to a location for a screening, the perceived benefits of having the procedure performed have to outweigh the perceived barriers, or an individual is less likely to submit to a test.

Two added features of HBM are *cues to action* and *self-efficacy*. A commercial, a brochure, and even the health care provider are all sources of action cues. In fact, health care providers are some of the most noted cues to action known. The doctor's advice carries a lot of weight in the eyes of most patients. Self-efficacy is the level of confidence a person has that they can perform a task. This can range from successfully getting to a test site to whether they feel they can be successful in changing a behavior.

Health promotion scientists often use the features within the HBM along with other models, because it is typically best to reduce as many barriers as possible, and targeted persons want to clearly understand the benefits of a procedure or behavior change.

Ecological Model of Health Promotion

Among the more comprehensive models used in health promotion efforts is the *Ecological Model*.[22] Developed to be a comprehensive model aimed more at a macro level, it has constructs that take into account both the micro and macro issues of the person. The Ecological Model has five areas for focusing efforts at assisting in behavior change. Each level should be considered as important as the others. The first is the *intrapersonal level*. This emphasizes micro-level issues a person has to overcome in order to change their behavior. This includes knowledge, attitudes, beliefs, and personality traits. Fortunately or unfortunately, it also includes genetics.

The next level of emphasis within the Ecological Model is *interpersonal relationships*. Interactions with family, friends, peers, or even the family doctor may determine what a person feels or believes about a given process or behavior. This can be a double-edged sword, in that sometimes these interactions have a positive effect on behaviors and sometimes they have a negative effect. The *community level* is considered next, and certainly has a macro level of influence. Social networks, community norms, and standards, whether formal or informal, sometimes determine which health behaviors are acceptable. *Institutional factors* or rules come next, followed by *public policy or laws*. Rules at work, such as no smoking policies, affect health, as do seat-belt laws, child safety-restraint laws, and even clean indoor air ordinances that restrict smoking in public places. Taking all of these levels of potential influence into effect can help aid the process of behavior change. Leaving one or more of these constructs out of any planning process for widespread behavior change will almost guarantee failure of a health promotion effort.

Though not a primary model used in helping individuals, the Ecological Model is a key to successful community public health efforts that has been proven time and time again to be successful in macro-level interventions. Any health care provider who wants to involve themselves in a role as a community health advocate would be wise to incorporate the constructs of the Ecological Model into their plan of attack.

Working with Patients Toward Behavior Change

Anyone who has made a change in behavior knows how difficult this can be. Sometimes it is difficult just to reach a jumping off point. Even then, many New Year's resolutions fail because the individual is poorly prepared and has few resources to help them reach their goals. Sometimes the goals themselves are too lofty.

Health care providers have an opportunity to serve as resource persons for patients who want to change their current behaviors. Even if a patient is a precontemplator, they still may move to the next level with some advice from their doctor. Counseling patients has been shown to be effective, especially when repeated messages are utilized. Although one does not have to be a jack-of-all-trades, it is important to realize that you may be their most influential cue to action. The importance of looking your patient straight in the eye and telling them that the desired behavior change is one of the most important things they can do today for their health cannot be understated. Telling them they need to make this proposed change a priority is equally important. They should be encouraged to set a date to put the change in motion. In addition, develop a list of resources to help them; for example, a brochure rack with appropriate information based on their stage of susceptibility for making a change or even a list of smoking cessation workshops in the area.

Do you have the number for a personal trainer, or the closest YMCA or community fitness center? What if a patient told you that they are ready to make a change in their behavior right now and have been looking for a person who could assist them? Would you be ready to help? If not, this could be worse for the patient than saying nothing at all.

The *abstinence violation effect* is a concept that applies to individuals who make an attempt to change a behavior and are unsuccessful. In essence, this is when they are told to lose 15 pounds before seeing the doctor again and are given no resources to be successful. They try on their own and fail, which causes them to experience this effect. It is the feeling that they have tried to abstain from a behavior and were not successful; therefore, they feel they can't do it and are less likely to attempt the behavior change again. When a health care provider says, "Change your ways," pats the patient on the back, and offers no other assistance, this is the likely outcome. Don't expect to change patients with your charisma. You need a plan, some resources, and a system to follow up so they don't get lost in the shuffle. Although this may not be your primary focus as a health care clinician, you are one of your patients' only knowledgeable sources for health care information; without you, patients are liable to make decisions based on faulty information from friends, social networks, and the Internet, which can be the least reliable places to find health information—particularly when it comes to behavior change.

One way to start the process of promoting health in your practice is to use the mnemonic of ABC'S.[23] The "A" is to remind clinicians to assess the actual health needs of the patient. What do they need to address right now? "B" is to remind clinicians to extol the benefits of positive behavior change. Sometimes it is better to stress the benefits of what they will gain by changing the behavior than to constantly remind them they are going to suffer negatives if they don't. This is called "gain-framing" the message. "C" is the use of regular chiropractic visits to facilitate this process. This doesn't mean that one should add extra visits to a treatment plan; instead, use those teachable moments during regular chiropractic visits to educate your patients. All practitioners have patients whom they see on a somewhat regular basis for chronic conditions or because the patient chooses the DC for preventive care. Start the process of advocating behavior change with these patients who already trust your message and your care. Then phase this practice in with all patients as it becomes possible to do so. Finally, the "S" is to remind you to keep up the stay the course messaging with your patients. Behavior change is a process and there are likely to be ups and downs for most patients. Encourage them to continue working toward their goals, which is indeed a process. Help them to set reachable goals and provide them with resources when possible that will assist in the process.

Learning More About the Behavior Change Process

There are many potential sources of information for helping patients change their behaviors. Repeated messages over time have been shown to produce positive effects and, because chiropractors typically encounter their patients several times for treatment, this gives them an added advantage over other health care providers—dose response; that is, you may have six, eight, or more visits with this patient during which you can "cue them to act." A visit to the family doctor twice a year provides fewer teachable moments. With this opportunity, however, comes the need to know more about how patients change. A guide to understanding health behavior change is available from the National Cancer Institute (NCI) of the National Institutes of Health, and can be downloaded from the NCI site free of charge at http://www.cancer.gov/theory. The guide, entitled *Theory at a Glance*,[24] describes several behavioral change theories and several planning theories as well. Each can assist you in understanding how to help people change their health-related behaviors.

Virtually all authorities in chiropractic now call on the profession to counsel patients on lifestyle changes. The American Chiropractic Association has a position statement on wellness[25] and the Association of Chiropractic Colleges' paradigm holds health promotion high in priority for doctors of chiropractic and the education institutions they serve.[26] In addition, the Council on Chiropractic Education has a standard that specifically directs colleges to teach, implement, and test for the ability to promote health at each accredited institution.[27] There is simply no reason that the chiropractic profession should not promote the counseling of patients about the preventable causes of disease that can be accomplished though lifestyle modification and behavior change. Helping patients add healthy years to their life is something both patient and provider gain from. For the clinician who chooses this course, perhaps very few other initiatives in practice will be so rewarding.

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CHAPTER 3

Public Health Research Methods

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CHAPTER OUTLINE

INTRODUCTION

Public health research methods encompass a vast array of approaches employed to investigate and promote population health. This chapter focuses on those strategies applicable to chiropractors in the field and to consumers and developers of research findings relevant to chiropractic doctors, patients, and policy makers. The chapter starts by discussing epidemiology, the "basic science of public health," and how epidemiologic principles are used in the design and interpretation of experimental and observational studies. The chapter then moves on to health services research and the role of epidemiologic methods in the use, analysis, and interpretation of secondary data. The chapter also touches on outcomes research and systematic reviews and how they are used in the development of guidelines and recommendations. Data collection and measurement are next, as is a brief but important discussion of ethics in public health research. The following section is an introduction to the

rapidly evolving field of community-based participatory research. Several notes of caution regarding the design of studies and the role of uncertainty in the interpretation of data are included after that. The chapter concludes with a discussion of emerging issues in research design, data collection and measurement, and analysis.

EPIDEMIOLOGY

Epidemiology is defined as the distribution and determinants of health and disease in human populations.[1] Epidemiologic principles are used to describe, explain, predict, and control disease in the population. Epidemiologic principles are also used in clinical situations to screen for, diagnose, and treat disease, and to evaluate disease prognosis and outcomes following care of patients. Thus, one of epidemiology's two major branches applies to populations and the other to individuals (i.e., clinical epidemiology). Both branches, however, rely on data from populations and probabilistic reasoning. A randomly selected person from a population with 50% of persons having a certain disease will have a 0.5 probability of having the disease. She either has or does not have the disease, but the probability is 0.5. Welcome to the wonderful world of uncertainty! Because public health focuses on population health rather than the health of specific individuals, public-health researchers are concerned with uncertainties in disease frequency and risk at the population level, whereas clinicians are concerned with uncertainties in diagnosis and prognosis at the patient level. The perspectives are compatible in theory but not necessarily congruent in practice. Keep this in mind as we begin our journey.

Measures Used in Epidemiologic Studies

Epidemiology has its place in public health and health care because disease is not randomly distributed. If it were randomly distributed, then we would have no way of describing disease patterns in terms of time (e.g., temporal trends), place (e.g., geographic variation), and person (e.g., individual characteristics or behaviors). Disease prediction and control would be impossible and epidemiologists (including yours truly!) would be out of business. Although in some cases disease occurrence may seemingly be random, it's likely due more to our ignorance of disease etiology and of risk factors for disease rather than being truly random. On the other hand, we have to be careful of attributing meaning to patterns that are in fact random.

Because virtually all epidemiologic studies involve sampling, computed measures are estimates and therefore subject to sampling (random) error. Confidence intervals are used to express the degree of uncertainty or statistical variability in our estimates. It is important to keep in mind, however, that confidence intervals do not take into account systematic (nonrandom) error or bias. The interested reader should consult Jewell[2] and Rothman et al.[3] for a comprehensive overview of these issues.

Measures of Disease Frequency

Measures used to describe disease frequency are prevalence and incidence. Prevalence is defined as the proportion of a defined population that has disease at a specific point in time, whereas incidence is the proportion of the population that develops disease over a specified period of time or the rate of disease occurrence in the population. For example, if 80 out of 1000 people surveyed report having low-back pain at the time of the survey, then the prevalence of low-back pain in this population is 80/1000 or 0.08 (8%). Prevalence may also be measured in terms of a period of time, such as 1-year or 2-week prevalence. This type of prevalence is called *period prevalence*. The period of time must be specified. For example, a period prevalence of 80% is meaningless without knowing what the period is (e.g., 1 year or 2 weeks). It's important to keep in mind, however, that prevalence measures are not rates of disease frequency.

Incidence may be measured in two basic ways: (1) cumulative incidence (risk), which is a proportion; and (2) person-time incidence, which is a rate. As with period prevalence, the period of time must be specified for a cumulative incidence to make sense. If 40 out of 1000 people at risk for a certain disease develop the disease over a 2-year period, then the 2-year cumulative incidence or risk is 40/1000 or 0.04 (4%). If we can measure or estimate the actual time that each person is at risk, then an incidence rate may be computed. For example, if there are 40 cases in 1000 years of person-time at risk, then the incidence rate is 40 per 1000 person-years or 0.04 cases per person-year.

Prevalence measures the burden of illness in a population, which is a function of incident cases and existing cases. Under certain (usually unmet) assumptions of population stability, lack of migration, and a low (<0.1) prevalence, prevalence is equivalent to the incidence rate times the mean duration of disease.[4]

Measures of Association

Epidemiologic studies may be conducted to describe disease or exposure patterns in populations or over time, or to estimate the associations between possible risk factors and disease occurrence. Prevalence and incidence and changes in prevalence and incidence are used primarily for descriptive purposes to explore trends and patterns, whereas measures of association are used when we want to make inferences about the effects of exposures on disease occurrence. These measures are of two basic types: (1) ratio measures, which have a null value of 1.0 indicating no association between the factor and the outcome; and (2) difference measures, which have a null value of zero.

An incidence (risk or rate) ratio is the ratio of two incidence proportions or rates. For example, if the 1-year incidence of neck pain is 0.08 in women and 0.04 in men, then the 1-year cumulative incidence or risk ratio is 0.08/0.04 = 2.0, indicating that the 1-year risk of neck pain is twice as high in women compared to men. The ratio measure alone doesn't tell us anything about the absolute risk of disease in the two populations that make up the ratio, however. For example, risks 10 times as great in women and men (0.8 and 0.4, respectively) would give us the same 2.0 risk ratio. When exposure-specific risks or rates cannot be computed, as with case-control data such as in the landmark Doll and Hill study of smoking and lung cancer,[5] odds ratios are the appropriate measures of association. Depending on the type of control sampling, odds ratios derived from case-control studies may equal or approximate rate or risk ratios. See Jewell[2] for details.

The incidence (risk or rate) difference gives us information on absolute risks or rates (i.e., absolute risk or rate reduction). Using the figures above, we would subtract the incidence in men from the incidence in women to obtain an incidence difference of 0.04 in the first case and 0.4 in the second case. Difference measures tell us how many more cases are in one group than another: 4 out of 100 more cases in women than men in the first example, and 40 out of 100 more cases in women than men in the second example. From a public-health perspective, difference measures are often more relevant than ratio measures. For example, a large ratio measure may simply reflect a very low baseline or unexposed risk, having little if any public-health importance. Using data from the Women's Health Initiative (a randomized trial of hormone replacement therapy [HRT]), rate ratios of the adverse effect of HRT on heart disease (1.29), invasive breast cancer (1.26), and stroke (1.41) reflect absolute risk increases of 7/10,000, 8/10,000, and 8/10,000 persons per year, respectively.[6] Twenty-nine to 41% increases may sound large, but in reality, are not very large when put in terms of the actual number of persons affected.

An analogous principle holds when estimating exposure effects in young vs. older people. A ratio measure may be very large in younger folks because the baseline risk is so low, not because the exposure is inherently more dangerous in the younger population. For this and other reasons, risks or rates should be reported in conjunction with ratio measures of association.

In order for the crude measures of association above to be used for *causal inference* about exposure effects, differences in risk according to place, or changes in disease risk over time, the exposure groups (e.g., exposed vs. unexposed), geographic areas being compared, or populations over time should be similar with respect to disease risk. If disease risks vary by comparison group, then estimates of association should be (1) standardized or adjusted for differences in disease risk (e.g., age), or (2) reported for specific categories (e.g., age-specific). For example, if exposure groups have different age distributions and age is a risk factor for disease, then the crude estimate of effect would be confounded by age. Age-standardized, age-adjusted, and age-specific estimates would be unconfounded by age (assuming no residual confounding). See Greenland et al.[4] for details on these and other adjusted measures, including standardized morbidity and mortality ratios.

Measures of Impact

It is often important to know the actual or potential impact of an exposure or intervention. For example, what proportion of cases in an unvaccinated population is due to the fact that individuals in this population were not vaccinated? If we know or can estimate the risks or rates of vaccine-preventable disease (VPD) in the vaccinated and unvaccinated groups (or the ratio of the risks or rates), then we can compute a measure called the attributable fraction (or proportion) among the exposed (AFE). For example, if VPD is twice as likely to occur in an unvaccinated group, then the attributable fraction among the unvaccinated is 50% ($[(2-1)/2] \times 100$). If we also know the proportion of VPD that was unvaccinated in the population, then we can compute the impact measure called population attributable fraction (or proportion), which tells us the proportion of cases in the total population (e.g., vaccinated and unvaccinated) that's due to being unvaccinated. If 9 out of 10 VPD cases are unvaccinated, then given the 50% AFE, 45% of all VPD cases could have been theoretically prevented

by vaccination (50% × 90%). These proportions have public-health relevance because they can help us estimate the potential impact of community-based prevention programs. It's important to note, however, that the proportions may not actually be "attributable" to the exposure (being unvaccinated in this example). We have to assume no confounding or other bias and a causal effect to make the inference that the estimated proportions are actually attributable to the exposure. Risk factor profiles may change over time and/or in association with changes in vaccination as well, so we cannot assume that the estimated impact measures will reflect the true impact.

A measure more commonly used in clinical situations but also having public-health relevance is the number needed to treat (NNT), which is the inverse of the risk difference comparing treated and untreated (or placebo) groups (i.e., absolute risk reduction). For example, if the risks of adverse outcomes are 0.02 and 0.08, respectively, then, on average, 17 persons (1/0.08 − 0.02) would have to be treated to prevent one adverse outcome (i.e., 17 people would have to be exposed to the intervention in order for 1 to benefit). This figure may be unacceptably large depending on the costs and harms associated with treatment. As noted in Hadler,[7] several popular (and costly) interventions have NNTs of greater than 50:

- Coronary artery bypass grafts, angioplasties, or stents to save lives or improve symptoms
- Arthroscopy for knee pain
- Any surgery for backache
- Statin therapy to reduce cholesterol and save lives
- Newer antidepressants for situational depression
- Drugs for decreased bone density
- Prostate specific antigen (PSA) screening and radical prostatectomy to save lives
- Screening mammography to save lives
- Several cancer treatments to save lives

Harms are taken into account by computing the number needed to harm (NNH), which is the inverse of the increased risk of harms. For example, if the treatment raises the risk of harm by 0.5% (0.005), then NNH would be 200. Depending on the severity of the harm, treatment-related harm in 1 out of every 200 persons treated may be unacceptably large.

Cost is an important measure of impact that public health researchers and policy makers must take into account. Space limitations of this book preclude an in-depth discussion here. Interested readers may refer to several recent articles, reports, and texts (e.g., Lakdawalla et al.,[8] Cohen et al.,[9] Thorpe et al.,[10] Trust for America's Health,[11] Jacobs[12]). Briefly, cost is commonly put in terms of return on investment (ROI), which compares dollars invested in the program to the benefits produced (ROI = [benefits of investment − amount invested]/amount invested). In the case of a prevention program, ROI compares the savings produced by the intervention to how much the program cost, so that when ROI equals zero, the program pays for itself; when ROI is greater than zero, the program produces savings that exceed the program's cost. Readers interested in learning about the methods of cost-effectiveness and cost-benefit in health care should consult Petitti.[13]

Experimental and Observational Study Designs

Epidemiologic study designs may be either experimental or observational. Experimental studies involve manipulation of the exposure or intervention by the investigator, whereas observational studies do not. Randomized clinical trials are experimental studies because the investigator assigns (by randomization) the exposure or intervention to the participants. If the exposure is assigned or determined in a way other than by randomization, the study is called quasi-experimental. Quasi-experimental studies may be one-group pre-post, or time-series designs that evaluate the effectiveness of an intervention or policy change, or may include multiple groups and comparators. Consult Cassidy et al.[14] and Cameron et al.[15] for studies evaluating the effects of changes in legislation on whiplash outcomes in Canada and Australia.

Studies in which exposure status is not influenced by the investigator (or a third party, as in a policy change, for example) are called observational because the investigator simply observes and does not manipulate the exposure. Cohort, case-control, cross-sectional, case series, and ecologic are all common types of observational studies used in epidemiologic and public health research. A "natural experiment" is a cohort study in which exposure groups are assumed to be, on average, the same as would have been obtained with randomization.[1] British physician and epidemiologist John Snow's natural experiment of the cholera outbreak in London in 1854 is a classic. The John Snow website created by UCLA epidemiology professor Ralph Frerichs is a must-view.[16]

Experimental Studies

Randomized trials and community intervention studies are two of the major categories of experimental studies.

Parallel-group randomized trials compare two or more groups involving treatment contrasts with (1) other treatments, (2) no treatment (e.g., "watchful waiting"), or (3) placebo. The major advantage of randomized studies over observational research is that we can assume (given a large number of randomized assignments) that the subjects in each group are, on average, similar with respect to prognosis. On average, at the time of randomization, the groups will be similar on all factors (both known and unknown) affecting outcomes. Thus, the possibility of bias due to confounding is minimized and the ability to make causal inferences is enhanced. Importantly, confounding in an experiment is random rather than systematic error as in observational studies.[17] The major disadvantages of experimental studies are that most exposures are not amenable to randomization (e.g., genetic and environmental factors) and noncompliance and crossovers over time may cloud data interpretation. Randomization typically occurs at the individual level, but may occur at the group level, such as the classroom, clinic, community, or worksite level (e.g., Kimura et al.[18]). Trust for America's Health, a nonprofit, nonpartisan organization dedicated to making disease prevention a national priority, recently reviewed randomized, quasi-experimental, and other community-based prevention studies of nutrition, physical inactivity, and smoking and other tobacco use.[11] (See **Figure 3-1**.)

Crossover trials are experiments in which all patients receive all exposures or interventions, but the order of the interventions is randomized. The major advantage of these studies is lack of confounding due to individual characteristics because the same person receives each intervention. Confounding may still occur due to factors that change over time, however. These studies work well for evaluating effects of treatments on conditions that are relatively stable over time, such as chronic back pain (e.g., Collacott et al.[19]). Factorial trials are efficient designs to estimate the effects of multiple treatments, as commonly provided by chiropractors. For example, manipulation vs. mobilization, heat, and electrical muscle stimulation were assessed in a recent $2 \times 2 \times 2$ factorial study of chiropractic patients with neck pain.[20]

Clinical trials are conducted to estimate the effects of treatments, which can be considered possible prognostic factors.[21,22] In contrast, most studies in public health and epidemiology focus on estimating the effects of possible risk (or preventive) factors for disease. Thus, the population at risk of the outcome (e.g., clinical improvement) in clinical trials is the population with the disease or condition (e.g., back pain), whereas in prevention studies (e.g., studies of primary disease prevention and health promotion, such as vaccine trials), the population at risk is without the disease of interest. Bauman and Koepsell[23] offer an excellent discussion of many of the epidemiologic issues in community intervention studies, as well as research methods specific to community trials and several examples. Of particular interest to readers of this chapter may be recent population-based quasi-experimental studies involving media campaigns designed to change beliefs about back pain[24–27] and sun exposure[28,29] in Australia.

Observational Study Designs

Observational studies may involve data collection at the individual level, as with experimental studies, or at the group level. Group-level data are used in ecologic studies, whereas individual-level data are used in all other observational studies. Ecologic studies are relatively quick and inexpensive to conduct; however, they come with a major disadvantage. Associations observed using group-level (aggregate) data may not be the same, and could in fact be in the opposite direction, as associations estimated using individual-level data. This is called the *ecologic fallacy*.[30] We don't know from aggregate data the cross-classification of exposure and outcome, thus we cannot fill in the cells of a 2×2 table and therefore

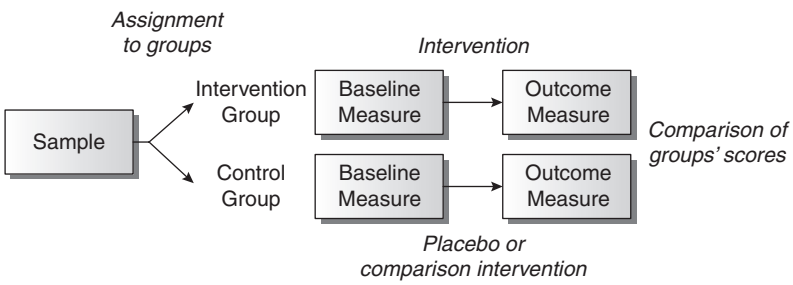

Figure 3-1 Basic clinical trial design.

cannot determine if exposed persons were more or less likely to be diseased than unexposed persons. An ecologic design was recently used to test the association between precipitation and autism.[31] An accompanying editorial discusses its strengths and weaknesses.[32]

Most public-health-oriented observational studies are cohort, case-control, or cross-sectional. Many, if not most, observational studies of a clinical nature are case studies and case series, which we will not discuss in detail here because the population at risk is unknown and they lack comparators; thus with few exceptions[33] they cannot be used to make causal inferences or generalizations, or inform public health policy. *Case reports* are useful for describing novel and interesting cases, which may be important in generating hypotheses, identifying disease features not previously known, or helping to detect the onset of a potential disease cluster or epidemic. Case reports are also important for identifying possible adverse drug reactions. The FDA MedWatch website[34] provides information about adverse event reporting, patient safety, and the role of case reports in postmarketing surveillance of drugs. Possible adverse reactions to vaccines are reported to the Vaccine Adverse Events Reporting System (VAERS).[35] However, this passive surveillance system has been reported to have several limitations, including inability to compute rates, lack of case verification, and under-reporting. *Adverse reactions* to chiropractic treatment are not collected in any systematic way; however, hundreds of case reports and a few cohort and cross-sectional studies have been published (e.g., Cagnie et al.,[36] Hurwitz et al.,[37] Rubinstein et al.,[38] Thiel et al.[39]).

No matter the study design, it's important to have in mind the population *at risk*, which excludes prevalent cases of the outcome of interest because they are not at risk of becoming an incident case (assuming the outcome is nonrecurrent). In cohort studies, a population at risk of the outcome (e.g., specific disease, death, or health outcome) is followed and outcome events identified over time (see **Figure 3-2**). If the population at risk, exposure(s) of interest, and outcome events can be identified from existing records or other data sources, then the cohort study is considered *retrospective*. If the cohort is identified in present time by the investigator and followed up prospectively, then the cohort study is considered *prospective* in nature. A cohort may be both retrospective and prospective if, for example, the population at risk is identified from occupational records, and outcome events (deaths in this case) are determined using mortality data as deaths accrue in future time. Exposure status is determined at baseline and changes in exposure status over time may be assessed by repeated questionnaires, interviews, physical examinations, or other means. The key to cohort studies, and indeed the necessary criterion for causal inference, is that exposure precedes occurrence of outcome (i.e., lack of temporal ambiguity).

Perhaps the most historically relevant and influential cohort studies (spanning 50 years) are the Framingham Heart Study and its offspring (e.g., Zhang et al.,[40] Fox et al.[41]), and the mortality studies of British doctors that emanated from Doll and Hill's pioneering 1950 case-control study of smoking and lung cancer cited in the U.S. Surgeon General's landmark 1964 report on the health effects of smoking. See the following references for a great historical perspective on the evolution of epidemiologic methods in public health research: Doll and Hill,[42] Doll and Peto,[43] Doll et al.[44,45]

Case-control studies may be population-based or non-population-based. *Population-based* case-control studies are similar to cohort studies in that a population at risk is identified, but instead of including everyone in the population at risk, the population-based case-control study includes only the cases and a sample of controls (noncases). The controls reflect the distribution of exposure in the population that gave rise to the cases. Prevalent or incident cases are identified from records or registries and controls are sampled from the population that the cases came from. Exposure status is typically determined by questionnaire or interview. It's helpful to think

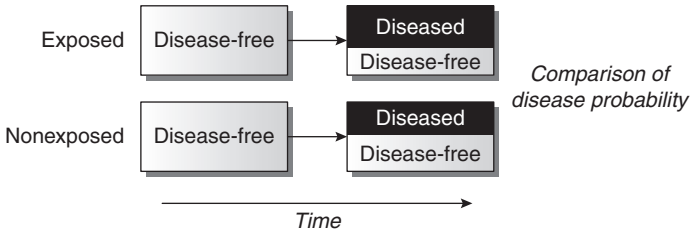

Figure 3-2 Basic cohort study design.

of population-based case-control studies as studies that are nested within a cohort, which is the population at risk. Like cohort studies, population-based case-control studies may be prospective, retrospective, or a combination of the two if some but not all cases have occurred prior to study initiation. The important point is that all cases are selected (not a sample), thus the potential for selection bias is minimized in population vs. non-population-based case-control studies.[17] See Rothwell et al.[46] for a population-based case-control study of chiropractic manipulation and stroke.

Non-population-based case-control studies do not involve a clearly defined population at risk. Cases and controls are selected, but not all cases from a population at risk are selected, and the controls do not necessarily come from the same population that the cases came from. (See **Figure 3-3**.) Therefore, the potential for selection bias is much greater in non-population-based case-control studies. Controls may be matched to cases on age, sex, or other factors that may influence outcome, but *matching* alone does not prevent confounding and may in fact introduce bias and statistical and cost inefficiencies. See Rothman et al.[47] for all of the excruciating details. To match or not to match? That is the question.

Cross-sectional studies collect data on exposures and outcomes simultaneously. The study population includes cases and noncases and there is no follow-up. The cases are prevalent rather than incident, thus we cannot generally distinguish acute cases from chronic ones, chronic (long-term) cases are overrepresented among the cases, and we cannot ensure that exposure preceded onset of disease. The lack of a population at risk, lack of follow-up, temporal ambiguity of exposure and outcome, and inability to distinguish risk from prognosis make cross-sectional studies particularly prone to errors in causal inference. However, if the study objective is primarily descriptive rather than inferential, findings from cross-sectional studies can be very useful, for example in describing the burden of disease and the prevalence of known or putative risk or prognostic factors in the population (e.g., Hurwitz and Morgenstern[48]). The Behavioral Risk Factor Surveillance System (BRFSS) designed and administered by the U.S. Centers for Disease Control and Prevention (CDC) has been used extensively for such purposes (refer to the BRFSS website[49] for additional information). Cross-sectional studies were used extensively by the National Bone and Joint Decade in its report on the burden (e.g., prevalence, societal, and economic cost) of musculoskeletal disease in the United States.[50] The National Health Interview Survey (NHIS)[51] and the National Health and Nutrition Examination Survey (NHANES)[52] are also important cross-sectional sources of health-related data from U.S. residents. The Pregnancy Risk Assessment Monitoring System (PRAMS),[53] a surveillance project of the CDC and state health departments, collects state-specific, population-based data on maternal attitudes and experiences before, during, and shortly after pregnancy.

Although most studies in public health can be identified as one of the above types, others are not clearly classifiable. Some are variants or combinations. For example, the case-crossover study has design elements of a cohort study as well as a case-control study. The study population in a case-crossover study is composed entirely of cases, which have been identified from a population at risk as in a cohort study or population-based case-control study. However, in lieu of a sample of controls, the cases serve as their own controls. Exposure status in a window just preceding case incidence (hazard period) is compared to exposure status in one or more windows in each case's history.[54,55] As with crossover trials, confounding from individual characteristics is minimized, though exposures or behaviors that change over time may still result in confounding. Case-crossover studies work well for acute-onset outcomes such as myocardial infarction, stroke, or traffic collisions, and with exposures that can trigger a short-term effect and that change over time such as physical exertion

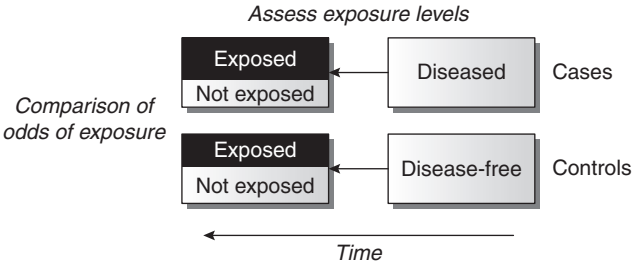

Figure 3-3 Basic case-control study design.

and cell phone use.[56] Unlike cohort studies with person-time at risk, case-crossover studies cannot be used to estimate exposure-specific rates (i.e., time to event) or long-term exposure effects where outcomes occur after the hazard period. See Cassidy et al.[57] for a good example of a case-crossover study and a case-control study from the same source population, as well as an interesting discussion on alternative explanations for the observed associations between exposure to health care providers (including general practitioners and chiropractors) and occurrence of stroke.

Interpreting the Evidence from Epidemiologic Studies

The ability to interpret evidence from published studies depends primarily on how well the authors reported their studies and results. Studies that are poorly reported may have been very well executed and relatively unbiased, but if we are left in the dark on key elements regarding sampling, measurement, or analysis, we won't be able to make an informed judgment of the study's internal or external validity. Fortunately, there are published guidelines for the reporting of randomized trials (parallel, cluster, noninferiority, equivalence, trials of herbal interventions, and harms), observational studies (cohort, case-control, and cross-sectional), diagnostic studies, and systematic reviews and meta-analyses (see the section "Systematic Reviews and Meta-analyses" later in this chapter). Unfortunately, authors do not always follow the guidelines and journals do not consistently enforce them.[58,59]

All studies should be evaluated for potential selection bias, potential misclassification (measurement error) of exposure and disease, potential confounding, potential for temporal ambiguity between exposure and disease, random error, and generalizability (*external validity*). Our goal in epidemiology is to obtain an unbiased and precise estimate of the true effect of an exposure or intervention on outcome in the population at risk. We don't know what the truth is; we use our study to estimate it. Because we don't know the correct value ("the truth"), we also cannot determine the specific amount of error in the estimate. Given enough information, however, and certain assumptions, we can make inferences about (1) how systematic error (bias) and confounding may have affected the study's *internal validity*, (2) the role of sampling error on our confidence in the estimates, and (3) the relative generalizability of the findings.

Keep in mind, however, that the relative importance of specific types of error depends on the level of inference needed. Therefore, assessing the validity of findings by use of simple checklists itemizing study features should be avoided. (Taking authors' conclusions at face value should also be avoided!) Different levels of inference have different requirements.[60] A first-level inference, association between exposure and disease among participants, only requires accurate measurements; a second-level inference, causal effect of exposure on disease in the study population, requires accurate measurements plus no confounding. A third-level inference, causal effect of exposure on disease in external populations, requires accurate measurements, no confounding, plus generalizability. A fourth-level inference, prevention of disease through elimination or reduction of exposure, requires accurate measurements, no confounding, generalizability, plus the ability to modify exposure. A fifth-level inference, substantial public health impact from elimination or reduction of exposure, requires accurate measurements, no confounding, generalizability, the ability to modify exposure, plus a large attributable fraction.

As you read and interpret the literature, you will find some investigators in the hypothesis-testing camp and others in the effect-estimation camp. Because (1) we are rarely in the position of having to make yes–no decisions about exposure effects, (2) definitive conclusions cannot be drawn from single studies, and (3) hypothesis testing ignores systematic error as alternative (nonchance) explanations for the data, the current consensus of epidemiologists is that estimating effects should take precedence over hypothesis testing.[2,17] Effect estimates with confidence intervals give us much more information than the P value, and dichotomizing the P value at an arbitrary value (e.g., 0.05 or 0.01) to determine "significance" is even less informative and potentially very misleading. Specifically, point estimates such as risk or rate ratios with their confidence intervals give us information on magnitude, direction, and precision, whereas the results of a hypothesis test tell us only whether a specific (usually null) hypothesis should be rejected or not. Most importantly, the P value confounds the strength of the association with the precision with which it is measured and does not account for selection bias, measurement error, and confounding. Therefore, a null hypothesis may be rejected in favor of a clinically meaningless association simply because of a large sample; and conversely, a clinically meaningful association may be rejected in favor of the null because of a relatively small sample, measurement error, or other bias. Regardless of the P value, the point estimate is the

"best" estimate given the data and the confidence interval (or P value function) gives the range of values that are compatible with the data.[17]

The CONSORT Statement

The *Consolidated Standards of Reporting Trials (CONSORT) statement* was originally developed and published in the mid-1990s to help authors improve the reporting of parallel-group randomized trials.[61] It has since been revised and extended to other experimental designs.[62–67] The CONSORT's 22-item checklist and flow diagram are designed so readers are better able to judge the validity of a trial's results. The specific items were selected because they have particular relevance to evaluating the potential for bias, reliability of the estimated effects, and relevance of the findings. **Table 3-1** shows the CONSORT checklist; **Figure 3-4** shows the flow diagram.

Items of particular importance in randomized controlled trials (RCTs) are highlighted in the flow diagram, which takes the reader through each stage of the trial from enrollment through intervention allocation and follow-up, to data analysis, and gives the numbers of participants at each stage allowing the reader to figure out if *intent-to-treat analysis* was performed. The chief advantage of randomized trials over observational studies is that given a large sample, randomization ensures that the treatment groups are prognostically similar at baseline. Analysis with "intent to treat" keeps the participants in their assigned treatment groups regardless of

Table 3-1 CONSORT Statement 2001: Checklist (Items to Include When Reporting a Randomized Trial)

PAPER SECTION and Topic	Item	Descriptor	Reported on Page #
TITLE and *ABSTRACT*	1	How participants were allocated to interventions (e.g., "random allocation," "randomized," or "randomly assigned").	
INTRODUCTION			
Background	2	Scientific background and explanation of rationale.	
METHODS			
Participants	3	Eligibility criteria for participants and the settings and locations where the data were collected.	
Interventions	4	Precise details of the interventions intended for each group and how and when they were actually administered.	
Objectives	5	Specific objectives and hypotheses.	
Outcomes	6	Clearly defined primary and secondary outcome measures and, when applicable, any methods used to enhance the quality of measurements (e.g., multiple observations, training of assessors).	
Sample size	7	How sample size was determined and, when applicable, explanation of any interim analyses and stopping rules.	
Randomization—sequence generation	8	Method used to generate the random allocation sequence, including details of any restrictions (e.g., blocking, stratification).	
Randomization—allocation concealment	9	Method used to implement the random allocation sequence (e.g., numbered containers or central telephone), clarifying whether the sequence was concealed until interventions were assigned.	
Randomization—implementation	10	Who generated the allocation sequence, who enrolled participants, and who assigned participants to their groups.	

(*continued*)

Table 3-1 CONSORT Statement 2001: Checklist (Items to Include When Reporting a Randomized trial) (*Continued*)

PAPER SECTION and Topic	Item	Descriptor	Reported on Page #
Blinding (masking)	11	Whether or not participants, those administering the interventions, and those assessing the outcomes were blinded to group assignment. If done, how the success of blinding was evaluated.	
Statistical methods	12	Statistical methods used to compare groups for primary outcome(s); methods for additional analyses, such as subgroup analyses and adjusted analyses.	
RESULTS			
Participant flow	13	Flow of participants through each stage (a diagram is strongly recommended). Specifically, for each group report the numbers of participants randomly assigned, receiving intended treatment, completing the study protocol, and analyzed for the primary outcome. Describe protocol deviations from study as planned, together with reasons.	
Recruitment	14	Dates defining the periods of recruitment and follow-up.	
Baseline data	15	Baseline demographic and clinical characteristics of each group.	
Numbers analyzed	16	Number of participants (denominator) in each group included in each analysis and whether the analysis was by "intention-to-treat." State the results in absolute numbers when feasible (e.g., 10/20, not 50%).	
Outcomes and estimation	17	For each primary and secondary outcome, a summary of results for each group, and the estimated effect size and its precision (e.g., 95% confidence interval).	
Ancillary analyses	18	Address multiplicity by reporting any other analyses performed, including subgroup analyses and adjusted analyses, indicating those prespecified and those exploratory	
Adverse events	19	All important adverse events or side effects in each intervention group.	
DISCUSSION			
Interpretation	20	Interpretation of the results, taking into account study hypotheses, sources of potential bias, or imprecision and the dangers associated with multiplicity of analyses and outcomes.	
Generalizability	21	Generalizability (external validity) of the trial findings.	
Overall evidence	22	General interpretation of the results in the context of current evidence.	

Source: CONSORT: Moher D, Schulz KF, Altman DG, for the CONSORT group. The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomized trials. *Ann Intern Med.* 2001;134:657–662.

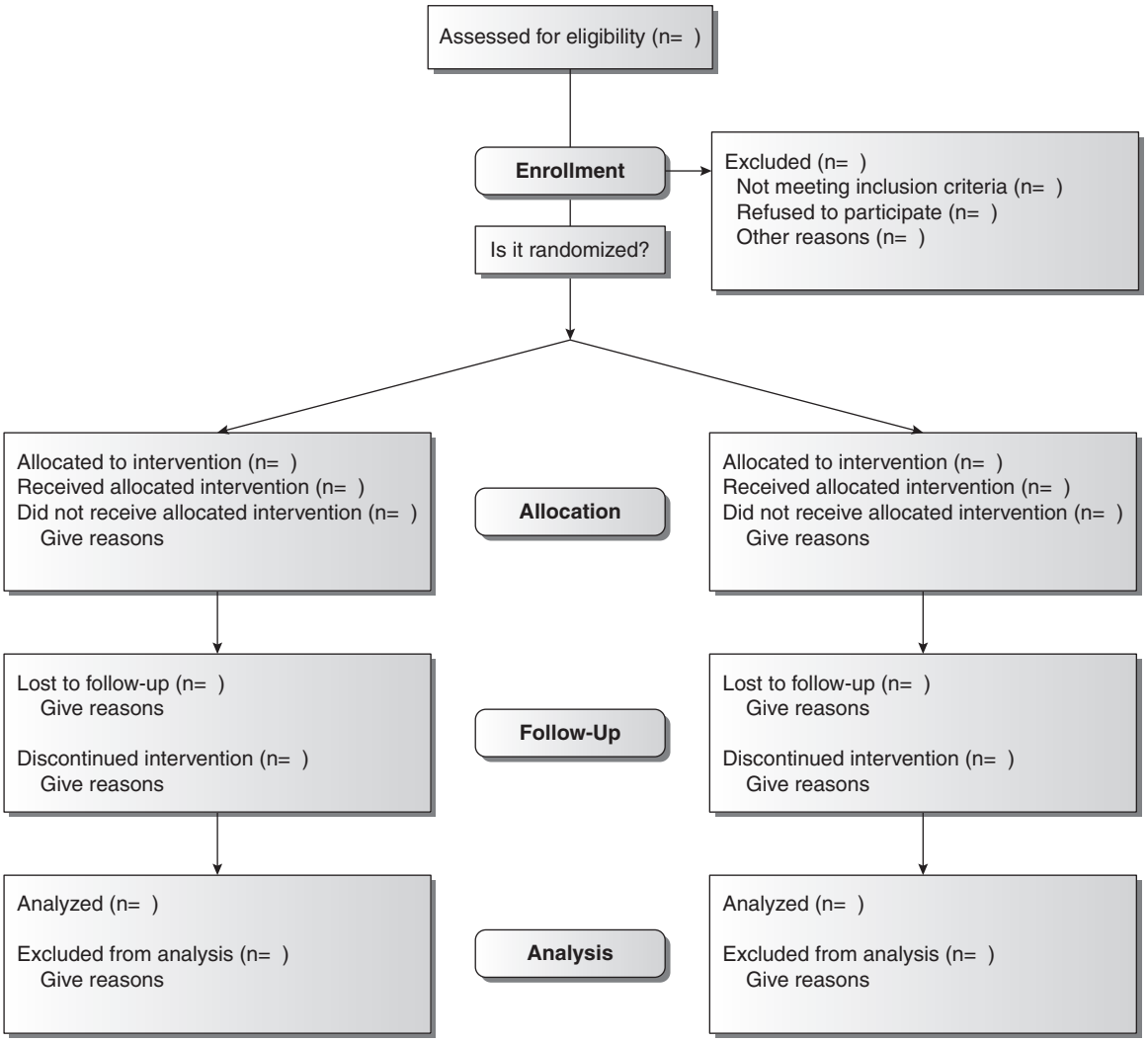

Figure 3-4 The CONSORT e-flowchart.

Source: Moher D, Schulz KF, Altman DG, for the CONSORT group. The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomized trials. *Ann Intern Med.* 2001;134:657–662.

compliance, thus preserving the baseline comparability. The alternative analysis is "as treated," or according to treatment actually received, which upsets the advantage of randomization because compliance is not random. Given noncompliance, the estimates derived from an as-treated analysis would be confounded if compliance is associated with prognosis and differential by treatment group, whereas estimates from an intent-to-treat analysis would be unconfounded but generally conservative (biased toward no effect if there is a true treatment effect) due to misclassification of treatment actually received. Therefore, in cases of imperfect compliance, intent-to-treat analysis does not reflect an actual treatment effect (efficacy), but rather the effect of treatment assignment, or intent-to-treat effect (effectiveness).

The STROBE Statement

The purpose of the *Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement* is

analogous to that of the CONSORT statement for randomized trials.[68,69] Features of observational studies necessary to judge their validity and possible inclusion in systematic reviews often go unreported; for example, specification of eligibility criteria, rationale for choice of confounding variables, and methods used to identify cases and controls. The STROBE statement is a 22-item checklist taking into account key components of observational study design, conduct, and analysis, with the goal of improving the reader's ability to judge what was done. Eighteen items apply to cohort, case-control, and cross-sectional studies, whereas four are design specific. Although the STROBE statement (like the CONSORT statement) is not meant as a quality assessment tool, transparent reporting is essential for judging strengths and weaknesses, potential for confounding and bias, and the study's relevance and generalizability. **Table 3-2** shows the STROBE checklist.

Of importance in all studies, but especially in observational research, is the ability to judge the potential for selection bias, information bias (e.g., measurement error), confounding, and the external validity (generalizability) of the findings. Several of the STROBE items call for the reporting of design and analytic elements that allow us to evaluate the study's internal and external validity.

Selection bias is a systematic error resulting from the procedures used to select subjects and from factors that influence participation. When the association between exposure and disease is different between study participants and nonparticipants, then selection bias may result. If the exposure–disease association among nonparticipants is unknown (as is usually the case), then the presence of selection bias must be inferred. An example of this would be an assessment of the efficacy of a screening test by comparing volunteers (self-selection) who choose to take the screening test with nonvolunteers (e.g., general community residents). An estimate of the efficacy of the screening test would be biased because volunteers are likely to have lower risk of disease regardless

Table 3-2 STROBE Statement (Checklist of Items That Should Be Included in Reports of Observational Studies)

	Item #	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract. (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found.
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported.
Objectives	3	State specific objectives, including any prespecified hypotheses.
Methods		
Study design	4	Present key elements of study design early in the paper.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection.
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up. *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls. *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants. (*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed. *Case-control study*—For matched studies, give matching criteria and the number of controls per case.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group.
Bias	9	Describe any efforts to address potential sources of bias.

(*continued*)

Table 3-2 (*Continued*)

Study size	10	Explain how the study size was arrived at.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding. (*b*) Describe any methods used to examine subgroups and interactions. (*c*) Explain how missing data were addressed. (*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed. *Case-control study*—If applicable, explain how matching of cases and controls was addressed. *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy. (*e*) Describe any sensitivity analyses.
Results		
Participants	13*	(*a*) Report numbers of individuals at each stage of study (e.g., numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analyzed). (*b*) Give reasons for nonparticipation at each stage. (*c*) Consider use of a flow diagram.
Descriptive data	14*	(*a*) Give characteristics of study participants (e.g., demographic, clinical, social) and information on exposures and potential confounders. (*b*) Indicate number of participants with missing data for each variable of interest. (*c*) *Cohort study*—Summarize follow-up time (e.g., average and total amount).
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time. *Case-control study*—Report numbers in each exposure category, or summary measures of exposure. *Cross-sectional study*—Report numbers of outcome events or summary measures.
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included. (*b*) Report category boundaries when continuous variables were categorized. (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period.
Other analyses	17	Report other analyses done (e.g., analyses of subgroups and interactions, and sensitivity analyses).
Discussion		
Key results	18	Summarize key results with reference to study objectives.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.
Generalizability	21	Discuss the generalizability (external validity) of the study results.
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the web-sites of *PLoS Medicine* at http://www.plosmedicine.org, *Annals of Internal Medicine* at http://www.annals.org, and *Epidemiology* at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

of whether they were screened or not. It's important to keep in mind the difference between the use of volunteers in randomized trials and the use of volunteers in observational studies. Volunteers in RCTs affect the study's generalizability (external validity) but not its internal validity, whereas volunteers in observational studies potentially affect both internal and external validity. Another example of selection bias is the "healthy worker effect." This effect results in a selection bias when "exposed" workers are compared with the general population. Because the workforce is healthier than the general population, if a study assesses the effect of an occupational exposure by selecting workers as the exposed group and compares their outcomes with an unexposed group from the general population, the estimated effect will be biased.

Information bias arises because information (data) collected about or from study subjects is inaccurate. The resulting bias is called "misclassification" if the variable is measured on a categorical scale (e.g., disease vs. no disease, exposed vs. unexposed) or when a continuous measure is categorized for analysis and the continuous variable is measured with error. Measurement error may be systematic or random. Exposure misclassification is nondifferential if unrelated to (i.e., independent of) occurrence or presence of disease, which results in bias toward the null when binary exposures are involved. Misclassification is differential if classification is related to (i.e., dependent on) occurrence or presence of disease, which results in bias toward or away from the null. Disease misclassification is nondifferential if unrelated to (i.e., independent of) exposure status, resulting in bias toward the null when binary outcomes are involved. Misclassification is differential if related to (i.e., dependent on) exposure status, resulting in bias toward or away from the null. For example, in case-control studies, *recall bias* may result in differential misclassification of exposure if those with the outcome are more likely to accurately recall the exposure (e.g., maternal recall bias) than those without the outcome. In this example, the estimate of exposure effect would be biased away from the null (i.e., estimated effect would be greater than the true effect). Blinding participants and researchers to the study hypothesis helps to prevent this type of bias.

Confounding is the confusion or mixing of effects, meaning that the effect of the exposure is mixed with the effect of another variable (confounder), resulting in bias. Randomization in experiments controls for both known and unknown confounders; strategies for controlling for known confounders in observational studies include restriction or matching in the design phase, and stratification, standardization, and modeling in the analysis phase (see Rothman et al.[70] for details). A confounding factor must have an effect (be a predictor of disease), be associated with the exposure, and not be an intermediate in the causal pathway between exposure and disease. For example, in an observational study designed to estimate the effect of a drug, confounding may occur because of differences in disease severity between those taking vs. not taking the drug. This type of confounding is called confounding by indication. Disease severity is a prognostic factor (predictor of disease outcome) and an indication for taking the drug, thus disease severity is a confounder. Because persons with initial symptoms of vertebrobasilar artery (VBA) stroke from a dissection in progress may seek chiropractic care due to their neck pain, confounding by indication is also a likely explanation for at least part of the association between chiropractic and stroke observed in several studies.[46,57] However, confounding by indication in these studies does not preclude the possibility that manipulation may be a causal factor for stroke in some patients.

The STARD Statement

Like randomized trials and observational studies, the reporting of diagnostic and screening studies has not been optimal. The *Standards for Reporting of Diagnostic Accuracy (STARD) statement* is an attempt to improve the reporting of such studies.[71] The statement includes a 25-item checklist and a flow diagram. **Table 3-3** shows the checklist; **Figure 3-5** shows the flow diagram.

Analogous to the requirements for different levels of inference in epidemiologic studies, there are different requirements for different phases of diagnostic research.[72] For a phase I question (Do test results in patients with the target disorder differ from those in normal people?), all that's required for such discrimination is a group of patients known to have the disease and a group of people definitely known not to have it. If the answer to the phase I question is positive, then we can go to phase II and ask the question: Are patients with certain test results more likely to have the target disorder than patients with other test results? Here again, the same two groups are needed as in the first phase, but data are laid out so sensitivity, specificity, and likelihood ratios can be computed. If the results look favorable under this ideal (nonroutine clinical practice) situation, then the phase III question may be asked: Does the test result distinguish patients with and without the target disorder among patients in whom it is clinically reasonable to suspect that the disease is present? Here we need to apply the diagnostic test under evaluation and the reference or "gold"

Table 3-3 STARD Checklist for Reporting of Studies of Diagnostic Accuracy

Section and Topic	Item #		On Page #
TITLE/ABSTRACT/ KEYWORDS	1	Identify the article as a study of diagnostic accuracy (recommend MeSH heading "sensitivity and specificity").	
INTRODUCTION	2	State the research questions or study aims, such as estimating diagnostic accuracy or comparing accuracy between tests or across participant groups.	
METHODS			
Participants	3	The study population: The inclusion and exclusion criteria, setting, and locations where data were collected.	
	4	Participant recruitment: Was recruitment based on presenting symptoms, results from previous tests, or the fact that the participants had received the index tests or the reference standard?	
	5	Participant sampling: Was the study population a consecutive series of participants defined by the selection criteria in items 3 and 4? If not, specify how participants were further selected.	
	6	Data collection: Was data collection planned before the index test and reference standard were performed (prospective study) or after (retrospective study)?	
Test methods	7	The reference standard and its rationale.	
	8	Technical specifications of material and methods involved including how and when measurements were taken, and/or cite references for index tests and reference standard.	
	9	Definition of and rationale for the units, cut-offs, and/or categories of the results of the index tests and the reference standard.	
	10	The number, training, and expertise of the persons executing and reading the index tests and the reference standard.	
	11	Whether or not the readers of the index tests and reference standard were blind (masked) to the results of the other test and describe any other clinical information available to the readers.	
Statistical methods	12	Methods for calculating or comparing measures of diagnostic accuracy, and the statistical methods used to quantify uncertainty (e.g., 95% confidence intervals).	
	13	Methods for calculating test reproducibility, if done.	
RESULTS			
Participants	14	When study was performed, including beginning and end dates of recruitment.	
	15	Clinical and demographic characteristics of the study population (at least information on age, gender, spectrum of presenting symptoms).	
	16	The number of participants satisfying the criteria for inclusion who did or did not undergo the index tests and/ or the reference standard; describe why participants failed to undergo either test (a flow diagram is strongly recommended).	

(*continued*)

Table 3-3 STARD Checklist for Reporting of Studies of Diagnostic Accuracy (*Continued*)

Section and Topic	Item #		On Page #
Test results	17	Time interval between the index tests and the reference standard, and any treatment administered in between.	
	18	Distribution of severity of disease (define criteria) in those with the target condition; other diagnoses in participants without the target condition.	
	19	A cross-tabulation of the results of the index tests (including indeterminate and missing results) by the results of the reference standard; for continuous results, the distribution of the test results by the results of the reference standard.	
	20	Any adverse events from performing the index tests or the reference standard.	
Estimates	21	Estimates of diagnostic accuracy and measures of statistical uncertainty (e.g., 95% confidence intervals).	
	22	How indeterminate results, missing data, and outliers of the index tests were handled.	
	23	Estimates of variability of diagnostic accuracy between subgroups of participants, readers, or centers, if done.	
	24	Estimates of test reproducibility, if done.	
DISCUSSION	25	Discuss the clinical applicability of the study findings.	

Source: Bossuyt PM, Reitsma JB, Bruns DE, et al. The STARD statement for reporting studies of diagnostic accuracy: Explanation and elaboration. *Clin Chem.* 2003;49:7–18.

standard to patients who are suspected of having the target disorder. The STARD statement forces investigators to explicitly consider and report on keys to validity including independent, blind comparison of test results with a reference ("gold") standard among a consecutive series of patients suspected of having the target disorder and inclusion of missing and indeterminate results, among others. Also of importance is the applicability of the findings to other settings, because test properties (e.g., sensitivity and specificity) may differ across settings (e.g., primary vs. secondary vs. tertiary care).

The ultimate value of a diagnostic or screening test depends on its ability to favorably affect health outcomes, ergo Phase IV: Do patients who undergo the test fare better in their ultimate health outcomes than similar patients who are not tested? A randomized study of patients undergoing the test vs. no test (or another test) and following them up would be required to answer this question with confidence. The line between diagnosis and intervention becomes quite opaque if we consider a prognostic criterion as a reference standard for diagnosis. For example, conditions like back and neck pain lack gold standard assessments, thus prognostic criteria are reasonable and the outcome measures used in treatment (outcomes) studies would also be used in phase IV diagnostic studies. The diagnosis is less important than the prognosis and outcome (e.g., how long will it take to get better, return to work, engage in usual activities, etc.?).

HEALTH SERVICES RESEARCH

Health services research (HSR) "examines how people get access to health care, how much care costs, and what happens to patients as a result of this care. The main goals of health services research are to identify the most effective ways to organize, manage, finance, and deliver high quality care; reduce medical errors; and improve patient safety."[73] The Agency for Healthcare Research and Quality (AHRQ) is the primary U.S. federal agency responsible for supporting HSR, providing evidence-based information on health care outcomes, quality, cost, use, and access, thus assisting patients, health care providers and administrators, and policy makers to make more informed decisions with the goal of improving the quality of health care services. For a good primer on the definitions

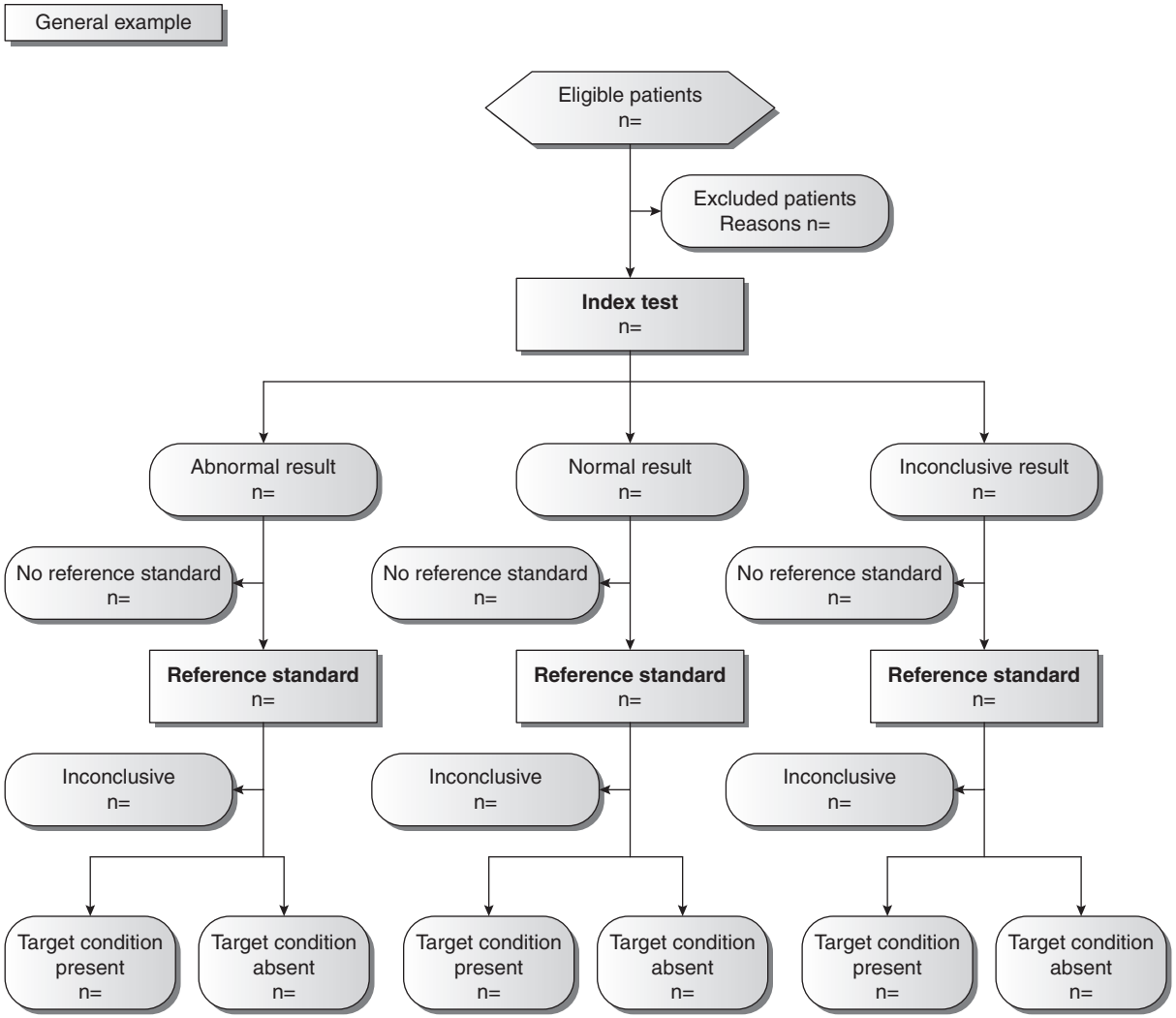

Figure 3-5 STARD flow diagram of a diagnostic accuracy study.

Source: Bossuyt PM, Reitsma JB, Bruns DE, et al. The STARD statement for reporting studies of diagnostic accuracy: explanation and elaboration. *Clin Chem.* 2003;49:7–18.

and measurement of quality of care, readers are encouraged to consult Amster et al.[74]

AcademyHealth is the key organization for health services researchers, policy analysts, and practitioners, promoting "interaction across the health research and policy arenas by bringing together a broad spectrum of players to share their perspectives, learn from each other, and strengthen their working relationships."[75] AcademyHealth defines HSR as "the multidisciplinary field of scientific investigation that studies how social factors, financing systems, organizational structures and processes, health technologies, and personal behaviors affect access to health care, the quality and cost of health care, and ultimately our health and well-being. Its research domains are individuals, families, organizations, institutions, communities, and populations."[76]

Health services researchers use many of the same study designs and methods that epidemiologists use for descriptive purposes and for causal inference. However, because of the ready availability of public and private health care data and health-related data from large state and national data sets, HSR uses existing data sources to a much greater extent. Health administrative databases from health plans and managed care organizations, data from the Centers

for Medicare and Medicaid Services (CMS), data from the ongoing AHRQ-funded Medical Expenditure Panel Survey (MEPS) and Consumer Assessment of Health Plans Study (CAHPS), as well as data from national surveys conducted on a routine basis by the National Center for Health Statistics, including the National Health and Nutrition Examination Survey (NHANES) and the National Health Interview Survey (NHIS), are a few of the many data sources mined by health services researchers. See Legorreta et al.,[77] Metz et al.,[78] Martin et al.,[79] Coulter et al.,[80] and Hurwitz and Chiang[81] for examples of how these data sources have been used in the chiropractic field. There are several public-access data sets and instructions available for use on the Internet.[82,83] NCHS's Health Data Interactive includes U.S. national and regional data on health and functional status, health care use and expenditures, health insurance and access, mortality and life expectancy, pregnancy and birth, and risk factors and disease prevention from several national data sources.[84]

A large component of HSR involves the review of existing primary literature on health care interventions and technologies, synthesis of the evidence, and development of practice recommendations and guidelines for use by physicians and other health care providers. For example, AHRQ supports several Evidence-Based Practice Centers throughout the U.S. charged with reviewing and synthesizing scientific evidence for conditions and technologies that are costly, common, or important to Medicare or Medicaid programs. Given that secondary data analysis, outcomes research, literature synthesis, and guideline development are commonly used in HSR, let's next examine these issues in some detail. Other important aspects of health services and the health care system in general, including issues regarding organization, management, and financing, and health care access and health care disparities, are dealt with elsewhere (Chapter 16).

Secondary Data

Secondary data analysis is the use of existing data to investigate research questions or address hypotheses without the need for primary data collection.[85] The original data may have been collected for other descriptive or analytic purposes, such as to describe patterns of disease or risk factors in the population (e.g., surveillance), or to address a specific hypothesis about disease etiology or the efficacy or effectiveness of a therapeutic or preventive intervention, or even from evaluation studies of programs or policies. The common denominator is the use of data not specifically intended to address the investigator's question of interest.

Sources of secondary data include previous studies, state and national data sets, tumor and other disease registries, the National Death Index, and administrative and clinical databases. Large prospective cohort studies such as the Framingham Heart Study, the Nurse's Health Study, and the Women's Health Initiative, among others, are mined to address ancillary questions not thought of when the cohorts were initially formed. Data from the RAND Health Insurance Experiment, for example, were used to look at the use and costs of chiropractic care many years after the experiment's termination.[86–88] Secondary analysis of the effects of nonrandomized variables from randomized trials must be considered as cohort studies rather than experiments because imbalances on nonrandomized variables must be taken into account in the analysis, and the nonrandomized exposure groups are not necessarily balanced with respect to both known and unknown confounders. The assessments of physical activity, patient satisfaction, and psychosocial factors as predictors of outcomes in recent randomized trials of back and neck pain patients are prime examples of this phenomenon.[89–91] The reason the RCT is the "gold" standard design is because the randomized groups, given a large enough sample, are balanced at baseline with respect to both known and unknown confounders.

The secondary data analyst may have little or no control over the selection of subjects, variables collected, types of variables, data quality, missing data, and so on. For example, the data set may not have information on potential confounders, or the responses to an outcome measure may be coded as categorical rather than continuous, thus introducing bias and precluding certain statistical analyses. Risk adjustment to control confounding may be suboptimal, as in the aforementioned case-control studies of chiropractic care and stroke.[47,57] Despite limitations, secondary data have their place, especially in health services research where effectiveness (vs. efficacy) of treatments and costs and use of services (e.g., utilization rates) are important research issues. Treatments identified as efficacious in tightly controlled RCTs may have different effects in other (real world) settings. The use of effective interventions may vary by region or by ethnicity, socioeconomic profile, gender, or other factors. Secondary data can be used to help explain geographic variations in use and understand health care disparities (i.e., differences in access according to sex, age, disability status, race/ethnicity, morbidity, and location [e.g., inner city, rural vs. urban]). For example, the Bureau of Health Professions' Area Resource File was used to look at chiropractic care in health professional shortage areas in the United States.[92]

Secondary data sources, such as medical records and medical claims databases, are the primary means used by pharmacoepidemiologists in postmarketing studies of the safety of drugs. Computerized medical records of the CDC's Vaccine Safety Datalink Project in association with several U.S. health insurance plans have been used to evaluate vaccine safety (e.g., Young et al.,[93] Haber et al.,[94] Klein et al.[95]). Selected case reports and small case series are informative for identifying events that may be causally related to treatment at the individual level; however, these studies are not informative for estimating population-based risks. Reliable denominator data are typically not available. Studies with comparators, preferably randomized trials, are needed to estimate the relative effects of treatments on harms; however, these studies (e.g., Phase III drug trials) are too small to estimate the effects of treatment on rare adverse events. As Ioannidis et al.[96] note, "rates of adverse events that are derived from single, modest-sized trials that are not statistically different typically do not exclude with certainty the possibility of major, clinically important differences in harms between groups." Systematic reporting of adverse reactions occurring in clinical care and in clinical studies would help clinicians and researchers better interpret harms-related data, improve the well-being of patients, and promote public health.[65] Many jurisdictions have national or provincial population-based registries to monitor drugs and medical devices; the United States does not.

Outcomes Research

Outcomes research is a subfield of health services research that focuses primarily on patient-oriented outcomes such as physical and psychosocial function, disability, mortality, return to work, overall quality of life, and satisfaction with care. Cost, use, and complications of health care may also be considered in outcomes research. Outcomes studies may be experimental or observational, and often use both primary and secondary data. For example, primary (questionnaire) data may be used to collect data on health-related quality of life, whereas secondary (administrative or billing) data may be used for cost and utilization outcomes.[97,98] Cohort studies are employed to compare the history of disease under different treatment regimens or management strategies, which may include active interventions or "watchful waiting." An important aspect of many outcomes studies as compared with traditional clinical trials is the former's inclusion of diverse patient populations, data collection from several practice settings, and consideration of a broad range of health outcomes. The practice-based cohort studies of back-pain patients undergoing chiropractic and medical care are excellent examples.[99,100]

Outcomes studies often use single or multi-item scales and indices to measure health constructs such as general well-being, comorbidity, illness severity, pain-related disability, depression, and stress. These measures may be the outcome variables or may be used to adjust or control for differences in risk or prognosis between patients or institutions. For example, changes in disability due to back pain may be the primary outcome in a cohort study comparing medical with chiropractic management, but if medical patients have higher initial disability or pain intensity, baseline disability and pain scores can be used to account for differences in prognosis. The 100-mm visual-analogue and 11-point (0–10) numeric rating scales for pain, and the 10-item Oswestry Low Back Pain Disability Scale and 24-item Roland-Morris Low Back Pain and Disability Questionnaire are frequently used measures of pain and back-pain-related disability. See Khorsan et al.[101] for a comprehensive review of outcome measures used in chiropractic research. The use and interpretation of self-administered assessment instruments for neck and low-back pain are covered in Nordin et al.[102] and Ostelo et al.,[103] respectively.

The 36-item Medical Outcomes Study short form (SF-36)[104] and the EuroQol Quality of Life Scale[105] are two of the most common self-administered measures of general health status. The SF-36 covers eight dimensions: physical functioning; role limitation due to (1) physical problems and (2) emotional problems; bodily pain; social functioning; general mental health; vitality, energy, and fatigue; and general health perceptions. The EuroQoL covers five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. In addition to their use in outcomes studies, these measures are also used in other HSR studies to derive quality-adjusted life expectancy. See McDowell and Newell[106] for a thorough discussion of these and many other general health- and condition-specific health status measures.

Because "health" and quality of life are underlying constructs rather than more directly observable phenomena like mortality or disease stages, special "psychometric" considerations apply. A brief overview of the relevant issues follows. Instrument-specific reliability, validity, and sensitivity to change and principles of psychometrics are dealt with comprehensively in McDowell and Newell.[106]

In addition to intra- and inter-examiner reliability and test–retest reliability, scales composed of multiple items should have internal reliability, meaning that the items making up the scale are measuring the same underlying

construct (i.e., the scale is internally consistent). In general, the larger the number of items, the higher the internal reliability as measured by Cronbach's alpha; however, more items results in greater response burden and possibly a greater likelihood of missing or erroneous data. Very highly correlated items may be dropped with little reduction in reliability. As with all measures, reliability of scales is population-dependent, and thus a scale shown to have adequate reliability should be reassessed in new study populations.

Validity of a scale refers to the extent to which it measures what it purports to measure. Different types of validity include face, predictive, convergence, and criterion.

- Face validity is the extent to which an instrument looks like it measures what it intends to measure.
- Predictive validity refers to the instrument's ability to predict the outcome.
- Convergence validity refers to the relationship between the instrument and other instruments that purport to measure the same construct.
- Criterion validity refers to how the instrument compares to the "gold standard" outcome.

Criterion validity is most often used in diagnostic studies of disease outcomes, but given the lack of gold standards for many patient-oriented outcomes (e.g., general well-being and quality of life), predictive and convergence validity are most often used in outcomes research.

Psychometrically sound scales are reliable, valid, and sensitive to changes in health status. In general, condition-specific indices are more sensitive to changes than generic indices because the former scales are more likely to include items (e.g., symptoms) that would be responsive to treatment. For example, the SF-36 includes one item on pain whereas all 24 Roland-Morris items are related to pain. Successful treatment may be reflected in the Roland-Morris score but reflect little, if at all, in the SF-36 score. It's important that measures can distinguish clinically meaningful changes over time and clinically important differences between treatment groups. A combination of generic and specific measures may be necessary to capture all important dimensions and to avoid ceiling and floor effects, which are more likely with generic than condition-specific measures.[107]

Note that measurement reliability and validity, discussed above, is different from estimation reliability and validity, which we discussed earlier in the section on interpretation of evidence from epidemiologic studies. Reliability (precision) of an estimate of effect is reflected in the width of the confidence interval, which is largely a function of sample size, whereas validity is reflected by the lack of systematic error (bias) from selection, information, and confounding.

Systematic Reviews and Meta-analyses

Existing data, primarily from secondary data analyses and outcomes research, are used in reviews of the literature to summarize the body of knowledge surrounding a particular research question. Systematic reviews, which involve the comprehensive identification of completed studies using explicit inclusion and exclusion criteria, are favored over narrative reviews because the latter are subject to error from the authors' selective inclusion of studies and nonstandardized assessment of their validity.[108] Given the rapidly expanding information base, it is impossible for any one person to read, critically appraise, synthesize, and remain up to date on the literature of even a fairly narrow field of interest. Systematic reviews are useful not only for summarizing the current state of the field, but also in identifying areas in need of further study and in developing clinical or public health recommendations or practice guidelines (see the following section "Recommendations and Guidelines").

A systematic review may include a meta-analysis, which is a statistical analysis of the primary studies conducted to test for heterogeneity and (if appropriate) generate a pooled (overall) estimate of exposure or treatment effect (e.g., Hurwitz et al.[109]). Summary estimates of effect should not be computed, however, if the primary studies differ appreciably in their methods or outcomes, called *heterogeneity*. Identifying sources of heterogeneity and possible explanations for differences in effect across studies is an important purpose of systematic reviews. For example, differences in participants, interventions, or outcome measures are potential reasons for heterogeneity. Readers interested in a comprehensive discussion of meta-analytic methods should consult Petitti.[13] Free software for meta-analysis has been validated[110,111] and is available for download (see the reference for Bax et al.[112] for a link to the website).

Although meta-analyses may be performed with observational studies as well as with randomized trials, the interpretation of estimates varies. With homogenous RCTs (e.g., similar patients, methods, and interventions), the meta-analysis will provide an unbiased estimate of the underlying treatment effect, with greater precision than estimates derived from the individual RCTs. Meta-analyses with observational studies, however, do not necessarily produce unbiased estimates. In fact, because of bias and confounding, pooled estimates of effect may

deviate widely from the truth (well beyond what would be expected by chance), with spurious precision due to sample-size gain from inclusion of multiple studies.

Publication bias is the most serious limitation of systematic reviews and meta-analyses. The problem arises because published studies are not representative of all studies conducted, and studies showing positive (statistically significant) results are more likely to be published.[113] Thus, even with an intervention or exposure having no effect, a meta-analysis based on published studies could identify an effect if negative trials go unpublished. Other factors associated with publication or inclusion in meta-analyses include sample size (larger studies are more likely to be published), funding source (pharmaceutical industry–supported trials are less likely to be published), number of sites (multisite trials are more likely to be published), language (English language articles are more likely to be included), duplicate publications (more likely to be included, and more likely to show positive results), and articles not indexed in computerized databases (e.g., Medline).[108] Given differences between published and unpublished studies in terms of study size and outcome, potential publication bias may be estimated by looking at the correlation between (or plot of) outcome and size. The so-called funnel plot, with sample size on the vertical axis and outcome on the horizontal (log outcome if ratio) axis, will have an apex near the summary estimate if there is little publication bias (i.e., small studies with both positive and negative findings are included). The plot will appear truncated on the left if there is evidence of publication bias, indicating the absence of small, negative studies.

The Cochrane Collaboration and Best Evidence Syntheses

Two major types of systematic reviews are Cochrane Collaboration reviews and best evidence syntheses. The Cochrane Collaboration was founded in 1993 with the aim of helping people make well-informed decisions about health care by preparing, maintaining, and promoting the accessibility of systematic reviews in all areas of health care. The work is performed by about 50 review groups that are tasked with updating summaries of the evidence and preparing and maintaining Cochrane reviews. See Gross et al.[114] for an example of work from the Cochrane Cervical Overview Group. The Cochrane Library is the main output, consisting of the Cochrane Database of Systematic Reviews and the Cochrane Controlled Trials Register, available on CD-ROM and on the Internet. Cochrane reviews are highly structured, and include quality assessments using predefined criteria, evidence tables, and frequently meta-analytic components. More information may be found at the Cochrane website.[115]

Best evidence syntheses share many of the features of Cochrane reviews, including comprehensive search strategies with explicit inclusion and exclusion criteria, critical appraisal, and evidence tables (concise summaries). However, appraisals focus on assessment of the presence of selection bias, information bias, and confounding, and the impact these have on the study's internal (and external) validity, without assigning quantitative scores.[116] Quality scoring of both RCTs and observational studies[117–119] does not necessarily relate to study quality. Best evidence synthesizers make an admissibility decision on the merits of each study based on quality indicators derived from fundamental principles of design, measurement, and analysis, consistent, for example, with CONSORT or STROBE guidelines. Only those studies having adequate internal validity are included in best evidence syntheses. The "best evidence" literature is then qualitatively synthesized, identifying consistencies and inconsistencies and attempting to provide explanations for discrepancies and heterogeneity. Summary statements describe the evidence, with more emphasis given to evidence from studies judged to be the least vulnerable to bias.[120] See Bronfort et al.[121] and Hurwitz et al.[122] for recent best evidence syntheses relevant to chiropractic.

A recent comparison of Cochrane and best evidence synthesis reviews indicates that review results and conclusions are sensitive to methods for appraising study quality and incorporating quality into data synthesis (at least when the evidence consists largely of low-quality trials). The authors conclude that both Cochrane and best evidence synthesis methods have strengths and weaknesses that people should be aware of when interpreting systematic reviews.[123]

MOOSE

MOOSE is not a ruminant mammal with humped shoulders and long legs and antlers, but rather the *Meta-analysis of Observational Studies in Epidemiology (MOOSE) group*. MOOSE convened in 1997 to "examine the reporting of meta-analyses of observational studies and to make recommendations to aid authors, reviewers, editors, and readers,"[124] and developed a 35-item checklist specifying key features of reporting a meta-analysis of observational studies vis-à-vis background, search strategy, methods, results, discussion, and conclusions. **Table 3-4** shows the checklist.

Table 3-4 A Proposed Reporting Checklist for Authors, Editors, and Reviewers of Meta-analyses of Observational Studies

Reporting of background should include:
- Problem definition
- Hypothesis statement
- Description of study outcome(s)
- Type of exposure or intervention used
- Type of study designs used
- Study population

Reporting of search strategy should include:
- Qualifications of searchers (e.g., librarians and investigators)
- Search strategy, including time period included in the synthesis and keywords
- Effort to include all available studies, including contact with authors
- Databases and registries searched
- Search software used, name and version, including special features used (e.g., explosion)
- Use of hand searching (e.g., reference lists of obtained articles)
- Use of citations located and those excluded, including justification
- Method of addressing articles published in languages other than English
- Method of handling abstracts and unpublished studies
- Description of any contact with authors

Reporting of methods should include:
- Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested
- Rationale for the selection and coding of data (e.g., sound clinical principles or convenience)
- Documentation of how data were classified and coded (e.g., multiple raters, blinding, and interrater reliability)
- Assessment of confounding (e.g., comparability of cases and controls in studies where appropriate)
- Assessment of study quality, including blinding of quality assessors: stratification or regression on possible predictors of study results
- Assessment of heterogeneity
- Description of statistical methods (e.g., complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated
- Provision of appropriate tables and graphics

Reporting of results should include:
- Graphic summarizing individual study estimates and overall estimate
- Table giving descriptive information for each study included
- Results of sensitivity testing (e.g., subgroup analysis)
- Indication of statistical uncertainty of findings

Reporting of discussion should include:
- Quantitative assessment of bias (e.g., publication bias)
- Justification for exclusion (e.g., exclusion of non-English-language citations)
- Assessment of quality of included studies

Reporting of conclusions should include:
- Consideration of alternative explanations for observed results
- Generalization of the conclusions (i.e., appropriate for the data presented and within the domain of the literature review)
- Guidelines for future research
- Disclosure of funding source

Source: Stroup DF, Berlin JA, Morton SC, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. *JAMA*. 2000;283:2008–12.

Key items in the checklist are those calling for reporting of subgroup (sensitivity) analyses, statistical uncertainty, assessment of potential publication bias, and consideration of alternative explanations for the results. Given the many sources of heterogeneity and of potential bias in observational studies, it is imperative that sufficient attention be given to heterogeneity, and that meta-analyses of observational studies are appropriately and conservatively interpreted.

QUOROM

QUOROM is not the number of group members needed to transact business, but rather the *Quality of Reporting of*

Meta-analyses (QUOROM) group. QUOROM convened in 1996 to "address standards for improving the quality of reporting of meta-analyses of clinical randomized controlled trials."[125] The group developed a statement, 21-item checklist, and flow diagram. See **Table 3-5** for the checklist and **Figure 3-6** for the flow diagram. The checklist emphasizes search, selection, validity assessment, data abstraction, study characteristics, and data synthesis.

An important point to keep in mind is that systematic reviews and meta-analyses are not experiments, but rather observational studies with the same if not greater potential for bias. Even reviews of RCTs are observational, thus the QUOROM group developed its checklist and flow diagram to guide authors to make explicit factors that are most likely to lead to bias, or to systematically influence estimates of treatment effect, especially important given that

Table 3-5 Improving the Quality of Reports of Meta-analyses of Randomized Controlled Trials: The QUOROM Statement Checklist

Heading	Subheading	Descriptor	Reported? (Y/N)	Page Number
Title		Identify the report as a meta-analysis [or systematic review] of RCTs		
Abstract		Use a structured format		
		Describe		
	Objectives	The clinical question explicitly		
	Data sources	The databases (i.e., list) and other information sources		
	Review methods	The selection criteria (i.e., population, intervention, outcome, and study design); methods for validity assessment, data abstraction, and study characteristics, and quantitative data synthesis in sufficient detail to permit replication		
	Results	Characteristics of the RCTs included and excluded; qualitative and quantitative findings (i.e., point estimates and confidence intervals); and subgroup analyses		
	Conclusion	The main results		
		Describe		
Introduction		The explicit clinical problem, biological rationale for the intervention, and rationale for review		
Methods	Searching	The information sources, in detail (e.g., databases, registers, personal files, expert informants, agencies, hand-searching), and any restrictions (years considered, publication status, language of publication)		
	Selection	The inclusion and exclusion criteria (defining population, intervention, principal outcomes, and study design)		

(*continued*)

Table 3-5 Improving the Quality of Reports of Meta-analyses of Randomized Controlled Trials: The QUOROM Statement Checklist (*Continued*)

Heading	Subheading	Descriptor	Reported? (Y/N)	Page Number
	Validity assessment	The criteria and process used (e.g., masked conditions, quality assessment, and their findings)		
	Data abstraction	The process or processes used (e.g., completed independently, in duplicate)		
	Study characteristics	The type of study design, participants' characteristics, details of intervention, outcome definitions, and how clinical heterogeneity was assessed		
	Quantitative data synthesis	The principal measures of effect (e.g., relative risk), method of combining results (statistical testing and confidence intervals), handling of missing data; how statistical heterogeneity was assessed; a rationale for any a-priori sensitivity and subgroup analyses; and any assessment of publication bias		
Results	Trial flow	Provide a meta-analysis profile summarizing trial flow (see figure 3-6)		
	Study characteristics	Present descriptive data for each trial (e.g., age, sample size, intervention, dose, duration, follow-up period)		
	Quantitative data synthesis	Report agreement on the selection and validity assessment; present simple summary results (for each treatment group in each trial, for each primary outcome); present data needed to calculate effect sizes and confidence intervals in intention-to-treat analyses (e.g., 2 × 2 tables off counts, means and SDs, proportions)		
Discussion		Summarize key findings; discuss clinical inferences based on internal and external validity: interpret the results in light of the totality of available evidence; describe potential biases in the review process (e.g., publication bias); and suggest a future research agenda		

Source: Moher D, Cook DJ, Eastwood S, Olkin I, Rennie D, Stroup DF. Improving the quality of reports of meta-analyses of randomized controlled trials: the QUORUM statement. Quality of Reporting of Meta-analyses. *Lancet*. 1999; 354:1896–1900.

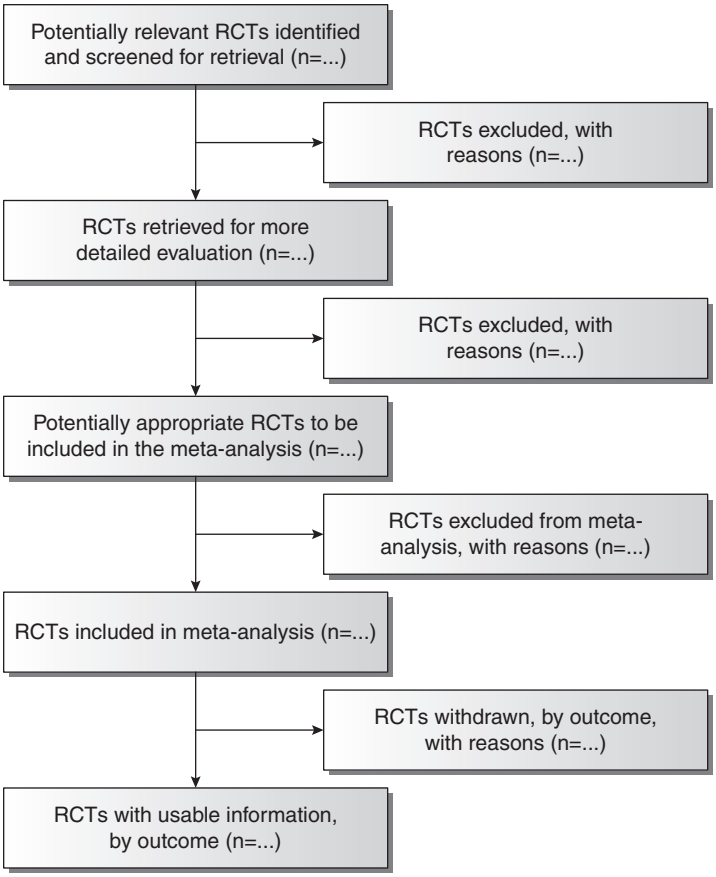

Figure 3-6 Improving the quality of reports of meta-analysis of randomized controlled trials: the QUOROM statement flow diagram.

Source: Moher D, Cook DJ, Eastwood S, Olkin I, Rennie D, Stroup DF. Improving the quality of reports of meta-analyses of randomized controlled trials: the QUOROM statement. Quality of Reporting of Meta-analyses. *Lancet*. 1999;354:1896–1900.

public health and clinical recommendations and guidelines stem from systematic reviews and meta-analyses.

Recommendations and Guidelines

Systematic reviews are the key ingredients feeding clinical and public health recommendations and clinical practice guidelines (e.g., Chou and Hoyt Huffman,[126,127] Carragee et al.,[128] Hurwitz et al.[122]). They are necessary though not sufficient, however. Development of recommendations and guidelines should take into account options, potential harms and benefits, preferences or relative values attached to harms and benefits, and costs and use of resources.[129–131] Historically, professional societies, governmental organizations, and others have used a variety of systems to appraise the evidence and develop guidelines, resulting in confusion, inconsistency, and suboptimal implementation and communication. Preferences, values, options, and resources vary from person to person and across geographic area, thus recommendations suitable for some people or places may not be suitable for others. Given that judgments are required, approaches for recommendation and guideline development should be as systematic, explicit, and transparent as possible.

Readers may be interested in recent clinical practice guidelines for the diagnosis and treatment of low back pain from the American College of Physicians and the American Pain Society[132] and clinical practice implications and recommendations on neck pain from the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders.[133]

As with diagnostic and therapeutic interventions and preventive programs such as screening and immunization

campaigns, grading evidence, coming to judgment on exposure and intervention effects, and making recommendations applies equally to food, nutrition, physical activity, injury prevention, occupational exposures, and other personal behaviors and modifiable factors. For example, in its recent cancer prevention report, the American Institute for Cancer Research used an inclusive or "portfolio" approach to assess the evidence and make recommendations, giving no particular study type preeminence but giving more weight to consistent findings from a variety of studies in diverse populations and categorizing their judgments regarding causality as "convincing," "probable," "limited—suggestive," "limited—no conclusion," and "substantial effect on risk unlikely."[134] Evidence strong enough to support judgments of "convincing" or "probable" justified goals and recommendations designed to reduce the incidence of cancer.

The U.S. Preventive Services Task Force (USPSTF) has been responsible for making evidence-based recommendations on preventive services for the past 24 years.[135] It released its first *Guide to Clinical Preventive Services* in 1989 and its most recent version in 2008.[136] Its objectives are to (1) evaluate the benefits of primary and secondary preventive services in apparently healthy persons based on age, sex, and risk factors for disease; and (2) make recommendations about which preventive services should be incorporated into primary care practice. The process leading to recommendations involves five steps:

1. Creation of an analytic framework and a set of key questions
2. Systematic review of the relevant literature
3. Quality rating of bodies of literature and of the evidence overall
4. Estimation of benefits and harms
5. Determination of the balance of benefits and harms of the service, or net benefit

The eight key questions are[137]:

1. Does screening for *X* reduce morbidity and/or mortality?
2. Can a group at high risk for *X* be identified on clinical grounds?
3. Are there accurate (i.e., sensitive and specific) screening tests available?
4. Are treatments available that make a difference in intermediate outcomes when the disease is caught early, or detected by screening?
5. Are treatments available that make a difference in morbidity or mortality when the disease is caught early, or detected by screening?
6. How strong is the association between the intermediate outcomes and patient outcomes?
7. What are the harms of the screening test?
8. What are the harms of the treatment?

Questions considered by the USPSTF for evaluating evidence related to key questions and to the overall certainty of the evidence of net benefit for the preventive service are:

1. Do the studies have the appropriate research design to answer the key question(s)?
2. To what extent are the existing studies of high quality? (i.e., What is the internal validity?)
3. To what extent are the results of the studies generalizable to the general U.S. primary care population and situation? (i.e., What is the external validity?)
4. How many studies have been conducted that address the key question(s)? How large are the studies? (i.e., What is the precision of the evidence?)
5. How consistent are the results of the studies?
6. Are there additional factors that assist us in drawing conclusions (e.g., presence or absence of dose-response effects, fit within a biologic model)?[135]

The recommendation is linked to a letter (A, B, C, D, or I) reflecting the magnitude of net benefit and the strength and certainty of the evidence supporting the preventive service:

- *A:* High certainty that net benefit is substantial (service recommended)
- *B:* High certainty that net benefit is moderate or there is moderate certainty that net benefit is moderate to substantial (service recommended)
- *C:* May be considerations that support the service in an individual patient; moderate certainty that net benefit is small (routine provision of service not recommended)
- *D:* Moderate or high certainty that service has no net benefit or harms outweigh benefits (service not recommended)
- *I:* Evidence lacking, of poor quality, or conflicting; balance of benefits and harms indeterminate (insufficient evidence to assess balance of benefits and harms)[138]

The GRADE Working Group

The Grades of Recommendation Assessment, Development, and Evaluation (GRADE) Working Group developed a systematic and explicit approach to making

judgments about the quality of evidence and the strength of recommendations, taking into account study design, quality, consistency, and directness, with consideration of balance between harms and benefits, applicability, and baseline risk.[129] It suggests four grades of evidence quality: high (further research very unlikely to change our confidence in the estimate of effect), moderate (further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate), low (further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate), and very low (any estimate of effect is very uncertain). GRADE poses two key questions that should be addressed when designing recommendations: (1) Does the intervention do more good than harm? (2) Are the incremental health benefits worth the costs? Regarding the former, the relevant categories are net benefits (more good than harm), trade-offs (important trade-offs between benefits and harms), uncertain trade-offs, and no net benefits.

GRADE cites four factors that should be considered when making a recommendation:

1. The trade-offs, taking into account the estimated effect size, confidence limits, and relative value of the outcome
2. Quality of the evidence
3. Translation of the evidence into practice, taking into account factors that could modify expected effect such as access issues
4. Uncertainty about baseline risk for the population of interest

It suggests categorizing recommendations as "do it" or "don't do it," or "probably do it" or "probably don't do it." The first two indicate judgments most well-informed people would make, and the latter two indicate judgments a majority of well-informed people would make but a substantial minority would not make. The Neck Pain Task Force used similar terms in its recent report: likely helpful or likely not helpful, and possibly helpful, might consider.[133] The GRADE Working Group and the Task Force agree that recommendations should not be made when little evidence is available, there's uncertainty or inconsistencies, or there are unclear trade-offs. Patients' preferences and values should be considered in all cases, but especially where the recommendation is to "probably do something" or that the intervention is "possibly helpful." Additional information about GRADE may be found at the GRADE Working Group website.[139]

The AGREE Collaboration

The Appraisal of Guidelines, Research, and Evaluation (AGREE) Collaboration is an international group of researchers from 13 countries that developed and validated an instrument for appraising the quality of clinical practice guidelines.[130] It used a multistaged approach that included generation, selection, and scaling of items, and field testing and refinement. Data analysis included evaluation of reliability and validity (face, construct, and criterion). The instrument was applied to 100 guidelines by over 260 appraisers from 11 countries. The 23-item instrument is available as a free download from the AGREE Collaboration website.[140]

The AGREE Collaboration cites six criteria or domains of high quality clinical practice guidelines: (1) scope and purpose, (2) stakeholder involvement, (3) rigor of development, (4) clarity and presentation, (5) applicability, and (6) editorial independence.

The COGS Checklist

As with RCTs, observational research, and systematic reviews and meta-analyses, being able to appraise the quality of guidelines is dependent on the quality of the reporting. Despite the Institute of Medicine's 1992 plea for clear and explicit guideline documentation,[141] guidelines published in the past several years have often failed to document key attributes such as criteria used to grade the evidence, literature review strategy, and the personnel involved in guideline development.[142] The Conference on Guideline Standardization (COGS) was convened in 2002 to define a standard for guideline reporting with the goals of promoting quality and facilitating implementation. So, CONSORT is to RCTs as COGS is to clinical practice guidelines. The 18-item COGS checklist is included in an article published in the *Annals of Internal Medicine* by Shiffman et al.[142]

Like CONSORT, the COGS statement is not meant as a quality appraisal tool but rather as an instrument to identify guideline components that should be reported. Quality should improve as guideline developers abide by COGS, just as the quality of clinical trials has improved following journals' requirement that clinical trialists follow the CONSORT statement.[143,144]

DATA COLLECTION

The validity of findings from public health–oriented studies depends in large part on the accuracy of data collection, an often unappreciated and undervalued

aspect of the research process. Data collection represents the "heavy lifting" of the research enterprise and the necessary bridge between study design and analysis. Data collection begins with identification of study participants and ends with the completion of the data file used for analysis. Given that opportunities for bias are present at every step of the way, we must be cognizant of the sources of potential bias and methods to minimize or eliminate them. The first opportunity for bias comes from participant screening, recruitment, and enrollment, which varies depending on study design, population, and setting. Assuring high participation rates is especially important in observational studies because selection bias may result if enrollment is associated with exposure and outcome. Low participation rates in experimental studies will not cause selection bias per se, but will reduce the generalizability of findings if, for example, exposure effects vary by race or ethnicity and the study includes only certain races or ethnicities. Obtaining high response rates and high-quality data from cases and controls in case-control studies and high response rates from all participants in cohort studies is imperative for preventing selection bias; however, it is becoming increasingly difficult due in large part to privacy and confidentiality concerns and the widespread use of cellular telephones. Researchers must balance respondent burden and requirements for quality data.

Data should be collected and managed in ways that allow participation and response rates to be computed. Data forms should be designed to capture numbers of subjects screened, excluded, enrolled, and followed up (if applicable), and reasons for refusal, exclusion, and loss to follow-up and noncompliance (if applicable). Demographic or other data from refusals and losses to follow-up may be used to assess the comparability of study population with source population. Informed consent and privacy issues may preclude data collection from refusals, however.

Record abstraction, questionnaires and interviews, and physical examinations (including biospecimen collection) are the primary modes of data collection in epidemiologic and health services studies. Existing public-health data for secondary analysis come from several sources, including the National Center for Health Statistics and other federal, state, and local health and health-information agencies. Each primary data-collection mode is discussed in the following sections, followed by a brief look at ethics in public health research. Groves et al.[145] is an excellent resource for those interested in more details on survey methodology.

Record Abstraction

Record abstraction is performed to extract data on exposures, outcomes, and other variables from occupational, medical, and other written data sources. Abstraction forms are typically designed with both open- and closed-ended response options allowing maximum flexibility for data reduction and analysis. Important features of abstraction forms are that the person's unique identifier is included on each page of the form, the beginning and end dates of each record are abstracted, and negative findings can be distinguished from items that were not performed. The latter is particularly important in chiropractic or medical record abstraction, where the distinction between a negative clinical test result and no test result is relevant. The abstraction form may include a "positive/negative/not found" response option. The need for interpretation should be minimized as much as possible. For example, exact date of birth (month/day/year) should be abstracted rather than age, which may be important when computing individuals' timing and history of exposure (or treatment) and making comparisons according to duration of exposure (or treatment).

Several records should be examined prior to designing the abstraction instrument, to avoid having to make modifications to the instrument mid-stream in the abstraction process. Chiropractic, medical, or occupational personnel responsible for primary data collection may need to be consulted. The abstraction instrument should be tested with several records prior to going out into the field. If more than one abstractor will be involved, the abstractors should independently abstract several records and inter-abstractor reliability should be assessed.[146] See Shekelle et al.[147] for the protocol manual and abstraction forms used in North American chiropractic spinal manipulation utilization and appropriateness studies.[141,148,149]

Questionnaire Development and Administration

Questionnaires may be developed for self-administration as hard copy, in electronic form for Internet or e-mail use, or for completion via in-person or telephone interview. Questionnaires may be mailed, sent electronically, downloaded from the Internet, or given to participants by project field personnel. Popular computer-intensive administration methods are computer-assisted personal interviewing (CAPI), computer-assisted telephone interviewing (CATI), and interactive voice response (IVR). Regardless of method, the goal is to obtain valid and reliable data that are comparable between comparison groups (e.g., cases

vs. controls, exposed vs. unexposed, treated vs. untreated). Because different methods have different response properties, the mode of administration should be consistent across groups.[145] The U.S. Centers for Disease Control and Prevention Epi Info is a public domain software package designed for public health researchers to create questionnaires, databases, and data entry programs, and to analyze epidemiologic data. It may be downloaded from the CDC website.[150]

Previously validated items and indices should be used whenever possible, though it is important to keep in mind that reliability is population-dependent, so even previously validated questionnaires should be examined for reliability in the study population. For example, health-related quality-of-life measures like the SF-36, back pain–specific measures like the Roland-Morris Low Back Pain Disability Questionnaire, and depression measures like the Center for Epidemiologic Studies Depression Scale (CES-D) have been used in many population groups; however, reliability is not consistent across groups.[106] Cultural, social, and other factors influence item interpretation, responses, index scores, and responsiveness to change over time. Pilot testing and standardization are essential.[147,151] The National Cancer Institute, the NCHS, and the AHRQ have banks of questionnaires available for viewing on the Internet.

As with medical record abstraction, missing data must be kept to a minimum. Respondent refusal to answer vs. a "don't know" or "no" response should be unambiguous. Therefore, a "yes/no/refused/don't know" response option is preferred to a simple "yes/no" option. Variables measured on a continuous scale should be asked in ways that preserve the scale, though compromises are often made to decrease respondent burden. When the scale is not preserved, means, standard deviations, and other statistics associated with interval-scale variables cannot be computed.

Ceiling and floor effects should be considered. For example, the visual analogue scale (VAS) or numerical rating scale (NRS) may be used for screening purposes and as an outcome measure in pain studies. Because little improvement can be measured in patients with a baseline of 10 or less on the 100-mm VAS or a1 on the NRS, they may be appropriately excluded. Participants' pain scores should be kept in the raw format rather than precoded (e.g., mild, moderate, severe) for descriptive purposes and to allow maximum flexibility in the analysis. Saris and Gallhofer[152] is an excellent resource for those interested in more details on questionnaire design and evaluation.

Physical Examinations

Physical examinations and biospecimen collection are increasingly being used in public health research. Examinations, which may include screening and diagnostic tests, are often used to identify cases for case-control studies and outcome events in cohort studies. Biospecimens (e.g., blood, urine, tissue) may be used for both exposure (including biomarker) and outcome assessment. Large national cross-sectional and longitudinal studies such as the NHANES include examination and biospecimen components. Interexaminer reliability and assay reproducibility are key issues, thus standardization, training, and quality control are of paramount importance.[146] In order to prevent misclassification, ideally all subjects in a study should undergo similar examinations and testing procedures. For example, controls in a case-control study should have undergone the same examination protocol as cases; otherwise, one or more controls may be misclassified as noncases in the case-control study.

ETHICS IN PUBLIC HEALTH RESEARCH

Space constraints preclude in-depth coverage of this important topic. Numerous resources are available for interested readers and budding researchers, however. The U.S. Department of Health and Human Services (DHHS) Office for Human Research Protections website is a good place to start.[153] We should all be familiar with the historical perspective, including Nazi war crimes and the Nuremburg Code, the U.S. Public Health Service's Tuskegee Syphilis Study, Dr. Henry Beecher's landmark 1966 article on ethics in clinical research in the *New England Journal of Medicine*,[154] the thalidomide disaster, the Declaration of Helsinki, and the U.S. National Research Act of 1974 that established the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. The Commission deliberated for 4 years and published the Belmont Report,[155] summarizing the basic ethical principles of research with human subjects: respect for persons, beneficence, and justice.

The U.S. Food and Drug Administration (FDA) and the DHHS codified regulations based on the Belmont Report in 1981. "The Common Rule" refers to DHHS regulations adopted by 17 federal agencies and outlined in Title 45 Code of Federal Regulations (CFR) Part 46 Subpart A. The Common Rule's three major components are: (1) institutional assurances, (2) institutional review board (IRB) review, and (3) informed consent. Research is defined as "a systematic investigation designed

to develop or contribute to generalizable knowledge." A human subject is defined as "a living individual about whom the investigator conducting research obtains data through intervention or interaction with the individual, or identifiable private information."[156] For more details, see the DHHS website.[157]

IRB Review and Informed Consent

Any research involving human volunteers and federal funds must be approved by an IRB prior to initiation of the research.[158] Although not legally required, ethical practice calls for IRB approval of human subjects research regardless of funding source. The IRB reviews the study protocol and materials with the following in mind:

- Appropriate procedures for informed consent
- Adequate protections for participants' privacy and confidentiality of collected information
- Minimization of risks
- Reasonable risks relative to benefits
- Special protections if vulnerable subjects are included (e.g., pregnant women, prisoners, children, persons with impaired decision-making capacity)
- Fairness in the selection of participants

Some research activities may be exempt from IRB review (e.g., surveys in which individuals cannot be identified through unique identifiers, studies using existing de-identified data); however, the IRB must make the determination. IRBs may also allow some studies to undergo an expedited review, for example, if the study involves minimal risk, defined as that "ordinarily encountered in daily life or during the performance of routine physical or psychological tests."[159] Again, the IRB rather than the investigator makes the determination by considering the magnitude and probability of risk.[160]

In response to security and privacy provisions in the Health Insurance Portability and Accountability Act (HIPAA) passed in 1996, DHHS issued Standards for Privacy of Individually Identifiable Health Information ("The Privacy Rule") in 2003. The Privacy Rule applies to individually identifiable health data obtained or kept by health plans or providers that transmit information (e.g., claims) electronically. In order to access these data, researchers must obtain consent from patients or obtain a waiver from the IRB or Privacy Board. Privacy officers may help researchers access information by de-identifying patients' data.

Adequate informed consent is more than simply asking a potential participant to read and sign a consent document. It is a process involving provision of information, assurance that the subject understands the requirements and risks and benefits of participation, and that initial and continuing participation in the study is entirely voluntary and free from coercion or undue influence, for example, from excessive compensation for participation. Written informed consent may be waived in certain cases, for example secondary analyses of public-use or de-identified data sets, studies with no more than minimal risk, or anonymous surveys, but as with waivers from IRB approval, it's the IRB's call, not the investigator's, to decide whether written consent may be waived.

Data and safety monitoring plans are required on any federally funded clinical trial, defined as "a prospective biomedical or behavioral research study of human subjects that is designed to answer specific questions about biomedical or behavioral interventions (drugs, treatments, devices, or new ways of using known drugs, treatments, or devices)."[159] Data and safety monitoring boards composed of persons independent of the research team are required on all multisite clinical trials entailing any possible risk to participants. Data and safety monitoring helps to ensure that the study is conducted safely and effectively, that risks are minimized, and that adverse events are detected and reported.[161]

Conflicts of Interest

Potential conflicts of interest arise because (1) the interests of the investigator and participant are not necessarily the same, and (2) the investigator may have financial, research, or another interest in the study outcome. Potential participants should be made aware of any interests unrelated to the patient's health that may affect the investigator's professional judgment or the patient's decision whether or not to participate in the study. For example, although the Declaration of Helsinki states that the interests of patients must come before the interests of physicians, science, and society, randomized trials are often conducted under nonequipoise states,[162] and many physicians admit to giving placebos to patients without their knowledge.[163]

Conflicts of interest are significantly affecting our ability to interpret the medical and public health literature and to have confidence in guidelines and recommendations derived from the literature.[164,165] Despite biomedical journals', government, and academic institution financial disclosure requirements, violations are all too common. Most recently, prominent psychiatrists from Emory and Harvard universities failed to disclose millions of dollars in income from pharmaceutical companies; another

high-profile researcher publishing a study on early detection of lung cancer failed to report funding from the tobacco industry; and the chairman of the psychiatry department at Stanford and incoming president of the American Psychiatric Association had a multimillion-dollar stake in a company while directing a study of one of its products. In recent studies, two thirds of academic medical centers were found to have financial ties to companies that sponsored research in their institutions, and two thirds of department chairs derived income from drug companies.[165]

According to a recent study, of 200 government panels that issued practice guidelines, more than a third of the authors had a financial interest in drugs they recommended, and many members of 16 standing committees that advise the FDA on drug approvals have financial links to pharmaceutical companies. FDA requirements that individuals with financial ties to drugs under deliberation recuse themselves are often waived.[165] USPSTF members are asked to disclose any information that may interfere with their ability to discuss and/or vote on a specific topic (e.g., financial, business/professional, and/or intellectual interest); however, disclosure is voluntary and members may still receive up to $10,000 per year from medical expert testimony or case review without the USPSTF considering such compensation a real or apparent conflict of interest.[135]

Here is the disclosure statement from a recent article on thimerosal exposure from vaccines and neurodevelopmental outcomes in which the authors concluded no association, when in fact the data are not incompatible with a causal association between early exposure to mercury and neuropsychological deficits in some children[166]:

> Dr. Thompson reports being a former employee of Merck; Dr. Marcy, receiving consulting fees from Merck, Sanofi Pasteur, GlaxoSmithKline, and MedImmune; Dr. Jackson, receiving grant support from Wyeth, Sanofi Pasteur, GlaxoSmithKline, and Novartis, lecture fees from Sanofi Pasteur, and consulting fees from Wyeth and Abbott and serving as a consultant to the FDA Vaccines and Related Biological Products Advisory Committee; Dr. Lieu, serving as a consultant to the CDC Advisory Committee on Immunization Practices; Dr. Black, receiving consulting fees from MedImmune, GlaxoSmithKline, Novartis, and Merck and grant support from MedImmune, GlaxoSmithKline, Aventis, Merck, and Novartis; and Dr. Davis receiving consulting fees from Merck and grant support from Merck and GlaxoSmithKline. No other potential conflict of interest relevant to this article was reported.

Given the cross-sectional data with retrospective measurement (despite the authors' assertion that the study is a prospective cohort), 30% response, selection bias, ignorance of nonlinear associations, confounding, and important exclusions, the authors' concluding no support for an effect is disingenuous and especially suspect with the plethora of conflicts of interest. Baker[167] offers a history lesson "for physicians and policymakers seeking to preserve the public's trust in the nation's vaccine system."

COMMUNITY-BASED PARTICIPATORY RESEARCH

An approach to research that includes the community in partnership with researchers is called *community-based participatory research (CBPR)*.[168] Its use has increased dramatically in the past decade as health disparities have widened and it has become apparent that significant improvements in public health will not occur without the input and buy-in from key stakeholders and other community members.[169] The increased awareness of the importance of life-course (social) epidemiology in contrast to proximal cause (risk factor) epidemiology, exemplified by the recognition that social class, economic, occupational, neighborhood, and other contextual variables have major effects on morbidity and mortality, has also contributed to the rise in CBPR.[170,171]

CBPR is a research model and a process, typically bottom-up (academic investigators help the community conduct their own research) vs. top-down (where community investigators conduct studies originating from academia) and employing any type of study design. The key to CBPR is that community members, persons affected by the health condition or issue under study, and other key stakeholders in the community have the opportunity to participate fully in the entire project, from conception, design, and conduct all the way to analysis, interpretation, and communication of results. This type of community–academic collaboration offers the potential to improve the quality and impact of research by generating better-informed hypotheses, developing more effective interventions, and enhancing the translation of the results into practice.[172]

A recent DHHS/National Institutes of Health (NIH) program announcement[173] lists the following ways CBPR may improve research quality and impact:

- More effectively focusing the research questions on health issues of greatest relevance to the communities at highest risk
- Enhancing recruitment and retention efforts by increasing community buy-in and trust
- Enhancing the reliability and validity of measurement instruments (particularly survey) through in-depth and honest feedback during pretesting

- Improving data collection through increased response rates and decreased social desirability response patterns
- Increasing relevance of intervention approaches and thus likelihood for success
- Targeting interventions to the identified needs of community members
- Developing intervention strategies that incorporate community norms and values into scientifically valid approaches
- Increasing accurate and culturally sensitive interpretation of findings
- Facilitating more effective dissemination of research findings to impact public health and policy
- Increasing the potential for translation of evidence-based research into sustainable community change that can be disseminated more broadly

An example of an innovative and successful public health–oriented CBPR initiative is the one launched by the National Institute of Environmental Health Sciences (NIEHS) in collaboration with the U.S. Environmental Protection Agency (EPA) and the National Institute for Occupational Health and Safety (NIOSH) in 1995.[174] Impetus for initiating the program emanated from findings from NIEHS's Environmental Justice: Partnerships for Communication Program, which found:

- Community members are challenged daily to make decisions about what exposures may be harmful to their health. Training and education to better understand the exposures and their sources empowers them to make informed decisions.
- Lack of communication has fostered distrust between community members and researchers. Tools and models to promote interaction and communication between the two groups foster trust and mutual understanding, which benefits researchers and community members.
- Active participation of community members in the identification of research questions provides residents with a sense of ownership and understanding of direct benefit to their public health. Consequently, residents are more likely to volunteer for and participate in the research project.

Greater community participation may benefit research outcomes in terms of

1. Methods for linking members of a community with researchers and health care providers (e.g., establishing community advisory committees)
2. Increased awareness and community role in identifying and defining problems and risks (e.g., fish consumption risk communication in Milwaukee, Harlem Children's Zone Asthma Initiative)
3. Inclusion of community in dialogue shaping research approaches to the problem (e.g., Healthy Food, Healthy Schools and Healthy Communities in Los Angeles)
4. Improved public health and policy change (e.g., pesticide exposure reduction among farm workers in Salinas Valley)[175]

Other examples of CBPR may be found in a report published by the Institute of Medicine, which also strongly favors a CBPR approach.[176]

A FEW NOTES OF CAUTION

Coffee causes pancreatic cancer. No it doesn't. Type A personality causes heart disease. No it doesn't. Margarine does a heart good. Not. Pesticides cause breast cancer. No they don't. Estrogen replacement therapy does not cause breast cancer. Yes it does. Beta carotene prevents cancer. Beta carotene causes cancer. Oral contraceptives (OCs) do not cause breast cancer. OCs cause breast cancer. Hormone replacement therapy (HRT) does a heart good. HRT does a heart bad. COX-2 inhibitors are good for treating peptic ulcer disease and should be recommended for use. COX-2 inhibitors cause heart disease and should be banned from use. In fact, the author of a provocative 2005 paper found that the results of five of six highly cited nonrandomized studies had been contradicted or had found stronger effects vs. nine of 39 randomized studies.[177] Possible implications: (1) observational studies are more prone to error than randomized trials; and (2) published research findings are as likely (or more likely) to be false than true.

Both implications are likely true. For example, a large well-conducted randomized trial with perfect compliance and complete follow-up will give an unbiased estimate of the intervention effect in the study population; however, because of failure to consider or measure possible confounders, for example, a similarly large and well-conducted observational study (e.g., case-control or cohort) will not necessarily produce an unbiased estimate in the study population.[59] As the editors of *PLoS Medicine* state, "the possibility that

most conclusions are false might be an inevitable part of the research endeavor."[178] Ioannidis[179] argues convincingly in favor of several corollaries about the probability that a finding is true:

- The smaller the studies conducted in a scientific field, the less likely the research findings are to be true.
- The smaller the effect sizes in a scientific field, the less likely the research findings are to be true.
- The greater the number and the lesser the selection of tested relationships in a scientific field, the less likely the research findings are to be true.
- The greater the flexibility in designs, definitions, outcomes, and analytical modes in a scientific field, the less likely the research findings are to be true.
- The greater the financial and other interests and prejudices in a scientific field, the less likely the research findings are to be true.
- The hotter a scientific field (with more scientific teams involved), the less likely the research findings are to be true.

We must all be comfortable with uncertainty because even if findings are true (i.e., internally valid), they are not necessarily generalizable (i.e., externally valid) nor applicable to individuals, ergo the tension between population health and the health of individuals. Benefits to the population may cause harms to individuals, as with universal vaccination programs.[180–182] Regarding external validity, studies of interventions conducted under ideal circumstances (so-called "efficacy trials") may yield different results under less controlled real-life situations ("effectiveness trials"). As noted in a recent editorial in the *American Journal of Public Health*, public-health researchers have historically emphasized internal rather than external validity, "which has contributed to our failure to translate research into public health practice."[183]

Because it is important for policy and administrative decision makers and others to know not only whether an intervention is effective, but also in which settings, populations, times, and so on, the *American Journal of Public Health* has established guidelines for reporting information that impacts external validity[183]:

1. Study participant recruitment and selection procedures, participation rates, and representative nature at the levels of individuals, intervention staff, and delivery settings.
2. Level and consistency of implementation across program components, settings, staff, and time.
3. Impact on a variety of outcomes, especially those important to populations, practitioners, and decision makers (e.g., quality of life, program costs, and adverse consequences).
4. Follow-up reports should include attrition at all levels in item 1, long-term effects on outcomes in item 3, and program sustainability, modification, or discontinuance.

The extent to which findings are externally valid depends largely on whether there are factors that modify the effect of the exposure or intervention. Effects that are similar no matter the time, place, or person can be easily extrapolated from a study to other populations; evidence of heterogeneous (interactive) effects warrants concern about generalizability. As Rothman[17] notes, "By identifying groups or settings in which interaction occurs, preventive actions can be more effective." For example, the adverse effects of aspirin are greater in children than in the elderly (age–aspirin interaction); the effect of alcohol on injury risk is much greater when driving than when not driving (alcohol–driving interaction); and vaccine components likely interact with genetic and/or other factors in some children to increase the risk of neurodevelopmental disorders (gene–environment interaction). Identifying and measuring these interactions and targeting our efforts on the modifiable factors involved in the interactions enable us to appropriately and efficiently focus limited resources, and maximize disease and injury prevention. Contrary to how statistical models are often interpreted, it should be noted that the relevant interactions having public-health implications are biological rather than statistical in nature. Lack of statistical (multiplicative) interaction implies biologic interaction. Refer to Greenland et al.[184] for a detailed discussion of biological interaction and effect-measure modification.

EMERGING ISSUES

In recognition of fundamental insights into the comprehensive understanding of disease etiology, prevention, and therapeutics, and the growing recognition that most major threats to public health are complex, involving a mix of behavioral, economic, social, and biological factors interacting over the lifespan and across many environments, the U.S. National Institutes of Health has identified several areas for increased funding over the next several years.[185–187] Here is a brief look at cutting-edge design, data collection and measurement, and analysis issues and innovations in public health research.

Research Design

Innovative study designs are needed to take into account the complexity of factors involved in disease incidence, prognosis, and prevention. Although the RCT is the gold standard study design, RCTs are neither appropriate nor feasible for many problems in public health, which must consider cultural, biological, and behavioral issues, and their interaction with genetics and the environment, among other variables.[188] The ability to make causal inferences and predictions of consequences of policy changes from nonexperimental research designs is indeed a challenge, but with new approaches involving multilevel designs, complex data sets with social network data, and data sets with geographic identifiers, inferences and predictions may be enhanced in the near future.

Data Collection and Measurement

Data validity and reliability depend on accurate data collection and measurement. Given the limitations of traditional self-report data, innovative approaches are being developed, including the use of hand-held beepers programmed for real-time data entry, computer-assisted interviewing with complex question sequences, and meters for continuous monitoring of biological systems, to name a few. However, these novel methods have not been assessed and validated in diverse populations. Methods are needed to reduce sampling, survey, and item nonresponse; to increase participation of eligible subjects; and to improve response rates on sensitive items. Contextual data, such as neighborhood composition and peer-group characteristics, are of increasing importance; however, techniques for accurately measuring and interpreting them are underdeveloped. For example, geographic information systems (GIS) and mapping technology have come a long way since John Snow mapped London's 1854 cholera outbreak, but GIS cannot differentiate good data from bad. Refer to the CDC's GIS in Public Health website[189] for more on the role of GIS in public health research.

Measures validated in one population may not be valid for use in other populations. For example, dietary, physical activity, and health status measures validated in White populations may not yield meaningful data in communities of different ethnicities due to variations in foods, activities, and perceptions of health and well-being. Perceptual, cognitive, cultural, demographic, motivational, and affective influences must be considered.

Perhaps the most recent innovation in data collection is Google Flu Trends,[190] which has the potential to assess trends and detect disease outbreaks earlier than existing surveillance systems. Engineers at Google came up with several keywords and phrases about "flu" and extracted 5 years of data on queries using these search words, finding an almost perfect correlation with the CDC's state and regional reports of influenza-like illness derived from lab, health care provider, death certificate, and other data. This methodology could be used as an early-warning system so prevention and control measures are instituted more quickly; however, validation has not yet occurred and it is unclear if Flu Trends would be any more timely than reporting systems based on emergency room and other data currently employed by public-health departments.[191] Interested readers should consult Brownson[192] to learn about the current state of the art in outbreak and cluster investigation.

Analytic Methods

Appropriate analytic methods must be developed to deal with new designs and data collection and measurement strategies. The goals remain the same, however: to improve estimation, hypothesis testing, and causal inference. The challenges are to develop techniques that distinguish true patterns from the noise of data variability and imprecise measurement. Systems science methodologies may be used to study the web of causal relationships that exist in public health problems.[193] For example, dynamic interrelationships of variables at multiple levels of analysis (e.g., cell, individual, community, society) can be studied simultaneously while evaluating the behavior of the system and its parts over time. As the NIH notes in its recent program announcement, these methodologies can also be used to "discover unanticipated effects of change on barriers to treatment and prevention services access, gaps in resource allocation, new training requirements, insufficient interorganizational linkages, and numerous other factors affecting healthcare systems improvements."[194] These methods have been used widely in other fields such as economics and ecology, but much less so in public health and health care.

To put these analytic methods in perspective and to find out "everything we know about what we don't know," I leave you with two entertaining and illuminating books on uncertainty and life that may very well change the way you look at the world: *The Black Swan: The Impact of the Highly Improbable*[195] and *The Drunkard's Walk: How Randomness Rules Our Lives*.[196] Enjoy the journey.

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CHAPTER 4

Environmental Health

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CHAPTER OUTLINE

Environmental health is a branch of public health that deals with human health issues associated with the factors present in the environment. Environmental health is concerned with all human health-related matters that directly or indirectly arise from factors associated with the environment. Therefore, it encompasses a broad range of environmentally related issues.

This chapter deals with those issues related to air, water, solid wastes, and hazardous wastes. Each of these plays a significant role in creating the atmosphere where we live, play, and conduct our day-to-day activities. Managing these properly has brought significant improvement to the environment and the health of the population living within this environment.

AIR

Air is needed for our survival. We could go for days without food and hours without water, but we would survive for only a few minutes without air. We need

oxygen for proper functioning of biochemical reactions within our body. On average we inhale over 3000 gallons of air per day. However, the air we breathe should be as free from pollutants as is possible.

Air Pollution, Our Health, and the Environment

Air pollution can make us sick and damage the environment in which we live. In October 1948, over 43% of the inhabitants of the city of Donora, Pennsylvania (population 12,000), became sick because of a thick fog and cloud of air pollution that lingered over this industrial city for 5 days. This fog was called the "killer fog" because it also killed 20 people.[1] There are numerous examples of such incidences occurring all over the world.

Air pollution affects us in many different ways. It can irritate our eyes, nose, and throat. It can also lead to difficulty in breathing, asthma, and various types of allergic reactions. It can cause various forms of chronic injuries, several of these leading to brain damage, nerve damage, and cancer. Each day we are sick, our productivity is decreased or affected, including lost days at work, school, and other activities. Children and the elderly are especially susceptible to the unhealthy effects of ozone, fine particles, and other airborne pollutants.

Air pollution also affects the health of animals, plants, crops, and the environment as a whole. Toxic air pollutants, acid rain, and ground-level ozone can damage trees, crops, wildlife, and bodies of water, including lakes. Various types of aquatic life including fish are also susceptible.

The Clean Air Act

The United States Congress passed the Clean Air Act in 1970. That same year it also established the Environmental Protection Agency (EPA) to promulgate and carry on the provisions of this act. Since then, the EPA has been responsible for carrying out the Clean Air Act programs so as to reduce air pollution throughout the United States. In 1990 the act was significantly revised and expanded.[2] The EPA was given a broader authority to implement and enforce regulations reducing air pollutant emissions. To ensure basic health and environmental protection, the EPA was required to set limits on the amounts of certain air pollutants allowed in the atmosphere. Although it is a federal law, state and local governments are required to perform their duties to meet the requirements of this act. Each state was required to develop state implementation plans (SIPs) to show how it would control air pollution.

The Clean Air Act has a list of comprehensive requirements encompassing different pollution sources and a variety of clean-up methods. All of these, when properly and routinely followed, lead to a significant reduction in the pollutants already present in the atmosphere.

Cleaning Up Commonly Found Air Pollutants

The EPA has classified six pollutants as *criteria pollutants*[3]; according to the agency, they are found all over the United States. These pollutants are:

- Particulate matter
- Ground-level ozone
- Carbon monoxide
- Sulfur oxides
- Nitrogen oxides
- Lead

The first two of these pollutants (particulate matter and ground-level ozone) pose the greatest threat to human health in this country.

Particles in the air vary in size and consist of solid and liquid droplets.[4] Particles can remain suspended in the air and may even move from one area to another with the wind. Over 20% of the particles that form haze in the Rocky Mountains National Park comes from areas hundreds of miles away. Even the presence of tiny fine particles in the atmosphere that can only be seen through an electron microscope are dangerous to human and animal health. The size of the particles that can remain suspended is variable. Therefore, in 1997 the EPA set limits on particles that can remain suspended in the air that are smaller than 2.5 microns; these are called PM2.5. Residential wood smoke from wood stoves, fireplaces, and outdoor wood-fire hydronic heaters contribute 6% or 420,000 tons of PM2.5 pollution in this country each year. The EPA therefore recommends wood stove users buy an EPA-certified model. Particles greater than 10 microns in diameter generally do not reach lungs, although they cause irritation to eyes, ears, and nose.[5] Chronic bronchitis is common in individuals who have inhaled particles of various sizes for a year or more.

Ground-level ozone is the main component of smog. Ozone is a colorless gas that occurs naturally in the Earth's upper atmosphere (the stratosphere), where it shields the Earth from the sun's ultraviolet rays. At ground level, however, ozone is an air pollutant and is injurious to human and animal health. It can damage

crops and forests, aggravate pre-existing respiratory diseases, and even cause pulmonary diseases. Chest pain and coughing are very common in individuals who are frequently exposed to ground-level ozone.[6]

Ground-level ozone is formed when two types of pollutants (volatile organic compounds [VOCs] and nitrogen oxide [NOx]) react in the presence of sunlight.[7] VOCs are released by automobiles using gasoline, petroleum processing plants, and a variety of chemical and paint manufacturing industries. NOx, which is reddish brownish in appearance, is produced by power plants, automobiles, and industrial boilers that burn gasoline, coal, and oil for energy. These pollutants together form ground-level ozone and unhealthy smog, especially during the hot summertime season.[8]

The EPA has published control guidelines and limits for all six pollutants. These limits are set up in two tiers. The first set of limits, based on the ill effects caused in humans, is called *primary standards*. The second set of limits, intended to prevent environmental and property damage, is called *secondary standards*. An area where the air quality is cleaner than the primary standard is called an attainment area. On the other hand, an area that does not meet the primary standard is called a nonattainment area.

Air Quality Index

The Air Quality Index (AQI) is a numerical index used by the government to define air quality at a given location each day. It is designed to inform the inhabitants of the area about the health effects of breathing the air in that location. The EPA measures five of the major air pollutants (particulate matter, ground-level ozone, carbon monoxide, sulfur oxide, and nitrogen dioxide) regulated by the Clean Air Act. The AQI ranges from 0 to 500. As the number increases, the health hazard associated with pollutants present in the air also increases. In general, an AQI below 100 is considered to be satisfactory whereas above 100 is considered a health hazard; the intensity of the health hazard increases as the level goes up. **Table 4-1** depicts the extent of health concerns based on the levels of pollutants present in the air.

There are six categories within the AQI, each of which corresponds to a different level of health concern.[9] Each category has the following meaning:

- *Good:* AQI of 0–50. The air quality is satisfactory and air pollution poses little or no risk.
- *Moderate:* AQI of 51–100. Air quality is acceptable, but there may be a moderate health concern for a small group of people; for example, those who are unusually sensitive to ozone may experience respiratory symptoms.
- *Unhealthy for sensitive groups:* AQI of 101–150. Although the general public is not likely to be affected at this AQI range, persons with pulmonary disease are at a greater risk from exposure to ozone, whereas persons with pulmonary and heart disease are at greater risk from the presence of particles in the air.
- *Unhealthy:* AQI of 151–200. Everyone may begin to experience some adverse health effects, although members of sensitive groups may experience more serious effects.
- *Very unhealthy:* AQI of 201–300. This would trigger a health alert signifying that everyone may experience more serious health effects.
- *Hazardous:* AQI of greater than 300. This would trigger a health warning of emergency conditions. The entire population at large is likely to be affected.

Table 4-1 Air Quality Index and Levels of Health Concern

Air Quality Index	Air Quality Conditions	Colors
0–50	Good	Green
51–100	Moderate	Yellow
101–150	Unhealthy for sensitive groups	Orange
151–200	Unhealthy	Red
201–300	Very unhealthy	Purple
301–500	Hazardous	Maroon

Source: U.S. Environmental Protection Agency. Air Quality Index: A Guide to Air Quality and Your Health. Available from the EPA at the AIRNow website: http://www.epa.gov/airnow/

Air Pollution Control

Many technologies are available that can be used to effectively control the amount and qualities of air pollution. They are sometimes costly, however, and their implementation must generally be mandated by laws.

Reducing Toxic Air Pollutants

Toxic air pollutants pose a great threat to the environment, and to the human and animal populations. Many are known to cause cancer, birth defects, reproduction problems, and a number of other serious illnesses. Several of these pollutants, for example lead and mercury, degrade very slowly or not at all. The majority of them come from man-made sources. For example, gasoline, when burned, produces a number of pollutants

that are emitted from the vehicle's tailpipe. Many small and large chemical factories, refineries, and incinerators produce small and large toxic particles.

Under the Clean Air Act of 1990, the EPA has regulated the emission of these agents into the air. With the help of recent developments in technologies, harmful air toxins from large industries have been reduced by nearly 70%. Technology-based regulations have been set since the year 2000, and at this time the EPA is considering several modifications including whether additional limitations may have to be initiated to reduce the release of pollutants into the atmosphere. Although no new national ambient air quality standards have been established so far, the U.S. Congress is fervently trying to get new pollution and climate control laws enacted. As of June 26, 2009, the U.S. Congress passed a Climate Control bill by a vote of 219–212.[10] However, its fate in the U.S. Senate has not yet been determined. This bill would require companies in the United States, including utility companies, oil refiners, manufacturers, and others, to reduce emissions of carbon dioxide and other gases associated with global warming by 17% by 2020 and 83% by 2050 from 2005 levels.

Reducing Acid Rain

Another EPA program, which went into effect in 1995 and was further modified in the year 2000, is the Acid Rain Program.[6,11] The program only targeted sulfur dioxide (SO_2) produced by the highest emitting power plants initially, but was expanded to require further reductions from the high emitters as well as to include some smaller facilities.

SO_2 and nitrogen oxide (NOx) are the main pollutants that lead to the formation of acid rain. Emissions of these pollutants in the air react with water vapor, forming acid rain. SO_2 emissions are produced from power plants burning coal and heavy oil, whereas NOx is produced during burning of gasoline in automobiles. Heavy rainstorms and melting snow can cause temporary increases in acidity in lakes and streams, especially in the eastern United States. When bodies of water become too acidic, certain fish species may become harmed or killed leading to a reduction in biodiversity.

The EPA's acid rain program has provided bonus allowances to power plants for installing clean coal technology that reduces SO_2 releases. In addition, the Clean Air Act of 1990 includes severe monetary penalties for plants that release more pollutants than are covered by their allowances. Cleaner gasoline from refiners and cleaner vehicle standards also have been put in place by EPA so as to produce fewer NOx emissions.

Ways to Reduce Air Pollution

In its "Plain English Guide to the Clean Air Act," the EPA provides a list of suggestions on "Ways to Reduce Air Pollution" that provides a way for the population as a whole to participate in day-to-day methods of controlling air pollution.

At home:

- Conserve energy, turn off appliances.
- Recycle paper, plastic, glass, cardboard, and aluminum cans.
- Keep woodstoves and fireplaces well maintained.
- Buy green electricity produced by low- or even zero-pollution facilities.
- Lower the thermostat on your water heater to 120°F.

Buy smart:

- Choose efficient, low-polluting models of vehicles.
- Choose reusable products and packaging.
- Buy rechargeable batteries for frequently used devices.

Drive smart:

- Plan your trips to combine errands, so you save gasoline and reduce air pollution.
- Keep tires properly inflated and aligned.
- Avoid waiting in long drive-thru lines.
- Use an energy-conserving grade of motor oil.

Conclusion

As can be understood from the statements contained in this section, being *air-wise* is an ideal way of carefree healthy living. An adequate supply of pollution-free air would help maintain community health as well as the environment in which we live. Industrial operations involving the use of cleaner energy sources than high polluting oil and coal would help reduce emissions of carbon dioxide and other gases in the atmosphere. However, a widespread reduction of pollution is only feasible when instigated at the national and international levels.

WATER

Water is the basic building block of the body's cells and tissues and is a key component of environmental health. The economic growth of a community is dependent upon a regular supply of clean, fresh water. Even though water is the most common natural resource

on the planet, only 3% of it is fresh water. Out of this small amount of fresh water, only 1% is easily accessible as ground or surface water.

Water Quality Standards

The quality of water for human consumption is regulated by state and federal laws and codes. These laws have set maximum pollutant contamination levels and require utility companies to publish reports at regular intervals concerning the extent of contaminants in their water supplies, as mandated by the Safe Drinking Water Act. The EPA and each state department of health is responsible for establishing drinking water quality standards; however, the U.S. Food and Drug Administration (FDA) sets regulations for bottled water.

The drinking water standards set limits for various substances that may affect consumers' health or the aesthetic qualities of drinking water. The charts presented in **Tables 4-2** and **4-3** show the water quality reports from the City of Huntington Beach, California,[12] and refer to the following points:

- *Maximum contaminant level (MCL):* The highest level of a contaminant that is allowed in drinking water.
- *Maximum residual disinfectant level (MRDL):* The level of disinfectant added for water treatment that may not be exceeded at the consumer's faucet.
- *Secondary MCLs:* These are set to protect the odor, taste, and appearance of drinking water.
- *Primary drinking standard:* MCLs for contaminants that affect health, along with their monitoring and reporting requirements and water treatment requirements.
- *Regulatory action level (AL):* The concentration of a contaminant that, if exceeded, triggers treatment or other requirements that a water supplier must follow.

Sources of Water Supply

Water is obtained from many sources. As an example, Orange County, California's water supplies are a blend of groundwater provided by the Orange County Water District (OCWD) and water imported from Northern California and the Colorado River by the Municipal Water District of Orange County (MWDOC) via the Metropolitan Water District of Southern California. Groundwater comes from a natural underground aquifer that is replenished with water from the Santa Ana River, local rainfall, and imported water (**Figure 4-1**).[12] The groundwater basin is 350 square miles and lies beneath north and central Orange County. More than 20 cities and retail water districts draw water from the basin to provide water to homes and businesses. Cities, counties, and private parties are duly authorized and licensed to distribute the water to individual homes.

Table 4-2 2007 City of Huntington Beach Water Distribution System

Disinfection By-products	MCL (MRDL/MRDLG)	Average Amount	Range of Directions	MCL Violation?	Typical Source of Contaminant
Total trihalomethanes (ppb)	80	23	20–52	No	By-products of chlorine disinfection
Haloacetic acids (ppb)	60	15–32	ND–32	No	By-products of chlorine disinfection
Chlorine residual (ppm)	(4/4)	1	0.10–2.8	No	Disinfectant added for treatment
Aesthetic Quality					
Color (color units)	15*	ND	ND	No	Erosion of natural deposits
Odor (threshold odor number)	3*	1	1–3	No	Erosion of natural deposits
Turbidity (NTU)	5*	0.10	0.01–0.36	No	Erosion of natural deposits

Sixteen locations in the distribution system are tested quarterly for total trihalomethanes and haloacetic acids; six locations are tested weekly for color, odor, and turbidity.
MRDL = Maximum residual disinfectant level
MRDLG = Maximum residual disinfectant level goal
NTU = Nephelometric turbidity unit
MCL = Maximum contaminant level
ND = No data

*Contaminant is regulated by a secondary standard to maintain aesthetic qualities (taste, odor, color).
Source: The 2008 Water Quality Report, City of Huntington Beach, Public Works Utilities Division.

Table 4-3 2007 City of Huntington Beach Drinking Water Quality, Local Groundwater and Metropolitan Water District, Treated Surface Water

Chemical	MCL	PHG (MCLG)	Average Local Groundwater	Average MWD Surface Water	Range of Detections	MCL Violation?	Typical Source of Contaminant
Radiologicals–Tested in 2006/2007							
Alpha Radiation (pCi/L)	15	(0)	4.5	< 3	ND–9.7	No	Erosion of natural deposits
Beta Radiation (pCi/L)	50	(0)	NR	< 4	ND–6.4	No	Decay of man-made or natural deposits
Uranium (pCi/L)	20	0.43	4.5	ND	ND–9.4	No	Erosion of natural deposits
Inorganic chemicals–Tested in 2007							
Aluminum (ppm)	1/0.2*	0.6	< 0.05	0.08	ND–01	No	Erosion of natural deposits
Arsenic (ppb)	10	0.004	< 2	< 2	ND–3.7	No	Erosion of natural deposits
Barium (ppm)	1	2	ND	< 0.1	ND–0.1	No	Erosion of natural deposits
Fluroid (ppm) naturally occurring	2	1	0.40	0.20	0.10–0.51	No	Erosion of natural deposits
Fluoride (ppm) treatment-related	Optimal Range 0.7–1.3		0.7–1.3	0.6 –1.0		No	Water additive for dental health
Nickel (ppb)	100	12	< 10	ND	ND–15	No	Erosion of natural deposits
Nitrate as NO_3 (ppm)	45	45	< 2	2.2	ND–6.9	No	Agriculture runoff and sewage
Nitrate and Nitrite as N (ppm)	10	10	< 0.4	0.5	ND–1.6	No	Agriculture runoff and sewage
Perchlorate (ppb)	6	6	ND	< 4	ND–4.1 (1)	No	Industrial discharge
Secondary Standards*–Tested in 2007							
Chloride (ppm)	500*	n/a	53	78	13–195	No	Runoff or leaching from natural deposits
Color (color units)	15*	n/a	1.6	2	ND–12	No	Runoff or leaching from natural deposits
Manganese (ppb)	50*	n/a	< 20	ND	ND–25	No	Erosion of natural deposits
Odor (odor units)	3*	n/a	< 1	2	ND–4	No	Naturally occurring organic materials
Specific Conductance (µmho/cm)	1,600*	n/a	598	676	364–1,070	No	Substances that form ions in water
Sulfate (ppm)	500*	n/a	58	117	24–179	No	Runoff or leaching of natural deposits
Total Dissolved Solids (ppm)	1,000*	n/a	351	391	206–724	No	Runoff or leaching of natural deposits
Turbididity (NTU)	5*	n/a	0.24	0.05	ND–0.6	No	Runoff or leaching of natural deposits
Unregulated Chemicals–Tested in 2007							
Alkalinity (ppm)	Not Regulated	n/a	162	88	80–196	n/a	Runoff or leaching from natural deposits
Boron (ppm)	Not Regulated	n/a	ND	0.16	ND–0.20	n/a	Runoff or leaching from natural deposits
Calcium (ppm)	Not Regulated	n/a	63	37	20–109	n/a	Runoff or leaching from natural deposits
Hardness, total (ppm)	Not Regulated	n/a	211	165	55–379	n/a	Runoff or leaching of natural deposits
Hardness, total (grains/gal)	Not Regulated	n/a	12	10	3–22	n/a	Runoff or leaching of natural deposits
Magnesium (ppm)	Not Regulated	n/a	10	17	1–23	n/a	Runoff or leaching from natural deposits

(*continued*)

Table 4-3 (*Continued*)

pH (pH units)	Not Regulated	n/a	8.2	8.2	8.0–8.5	n/a	Hydrogen ion concentration
Potassium (ppm)	Not Regulated	n/a	2.6	3.4	1.5–4.3	n/a	Runoff or leaching from natural deposits
Sodium (ppm)	Not Regulated	n/a	47	71	31–93	n/a	Runoff or leaching from natural deposits
Total Organic Carbon (ppm)	Not Regulated	IT	NR	2.2	1.9–2.9	n/a	Various natural and man-made sources
Vanadium (ppb)	Not Regulated	n/a	< 3	3.3	ND–6. 6	n/a	Runoff or leaching from natural deposits

(1) Perchlorate detection is from a USEPA Unregulated Contaminant Monitoring Rule test in 2003. Perchlorate was not detected in treated water samples tested in 2007. Perchlorate became a regulated chemical in California drinking water in 2007.

ppb = parts-per-billion; ppm–parts-per-million; ppt = parts-per-trillion; pCi/L = picoCuries per liter; ntu = nephelometric turbidity unites; mmho/cm = micromhos per centimeter;
NR = not required to be analyzed; ND = not detected; < = average is less than the detection limit for reporting purposes; MCL = Maximum Contaminant Level; (MCLG) = federal MCL Goal; PHG = California Public Health Goal; n/a = not applicable; LSI = Langelier Saturation Index; *Contaminant is regulated by a secondary standard.

Turbidity–combined filter effluent Metropolitan Water District Diemer Filtration Plant	**Treatment Technique**	**Turbidity Measurements**	**TT Violation?**	**Typical Source of Contaminant**
(1) Highest Single turbidity measurement	0.3 NTU	0.06	No	Soil run-off
(2) Percentage of samples less than 0.3 NTU	95%	100%	No	Soil run-off

Turbidity is a measure of the cloudiness of the water, an indication of particulate matter, some of which might include harmful microorganisms. Low turbidity in Metropolitan's treated water is a good indicator of effective filtration. Filtration is called a "treatment technique" (TT).
A treatment technique is a required process intended to reduce the level of contaminants in drinking water that are difficult and sometimes impossible to measure directly.

Source: The 2008 Water Quality Report, City of Huntington Beach, Public Works Utilities Division.

Water is seldom used for drinking purposes without some form of purification and disinfection treatment. Well water is one exception, however, which is usually free from contamination because the water is filtered through the soil before becoming groundwater. Well water should be tested regularly for the presence of microorganisms and other impurities and treated when necessary. Water can be purified for drinking purposes using many different procedures: gas exchange, coagulation using aluminum sulfate, flocculation, sedimentation, filtration, ion exchange, activated carbon adsorption, and even distillation. These processes substantially reduce the number of microorganisms in the water.

Water Pollution and Contaminants

Water pollution sources can be divided into two categories[13,14]:

- *Point source pollutants:* These come from a single-source, defined location. Pollutant sources in this category include industrial plants, sewage treatment plants, factories, or municipal storm drains.
- *Non-point source pollutants:* These do not come from a specific location. They can include a variety of wastes, nutrients, and potentially toxic substances, and generally come from a number of diverse sources. Frequently these are the cumulative effect of several different types of contaminants gathered from a large area.

The EPA, FDA, and individual state departments of public health have regulations that limit the contaminants that can be present in tap and bottled water. In some instances, the contaminant level allowed by law is so small it generally does not pose a health problem in healthy individuals; however, it could be a problem to immunocompromised individuals. Such individuals must consult their health care providers before consuming tap and/or bottled water.

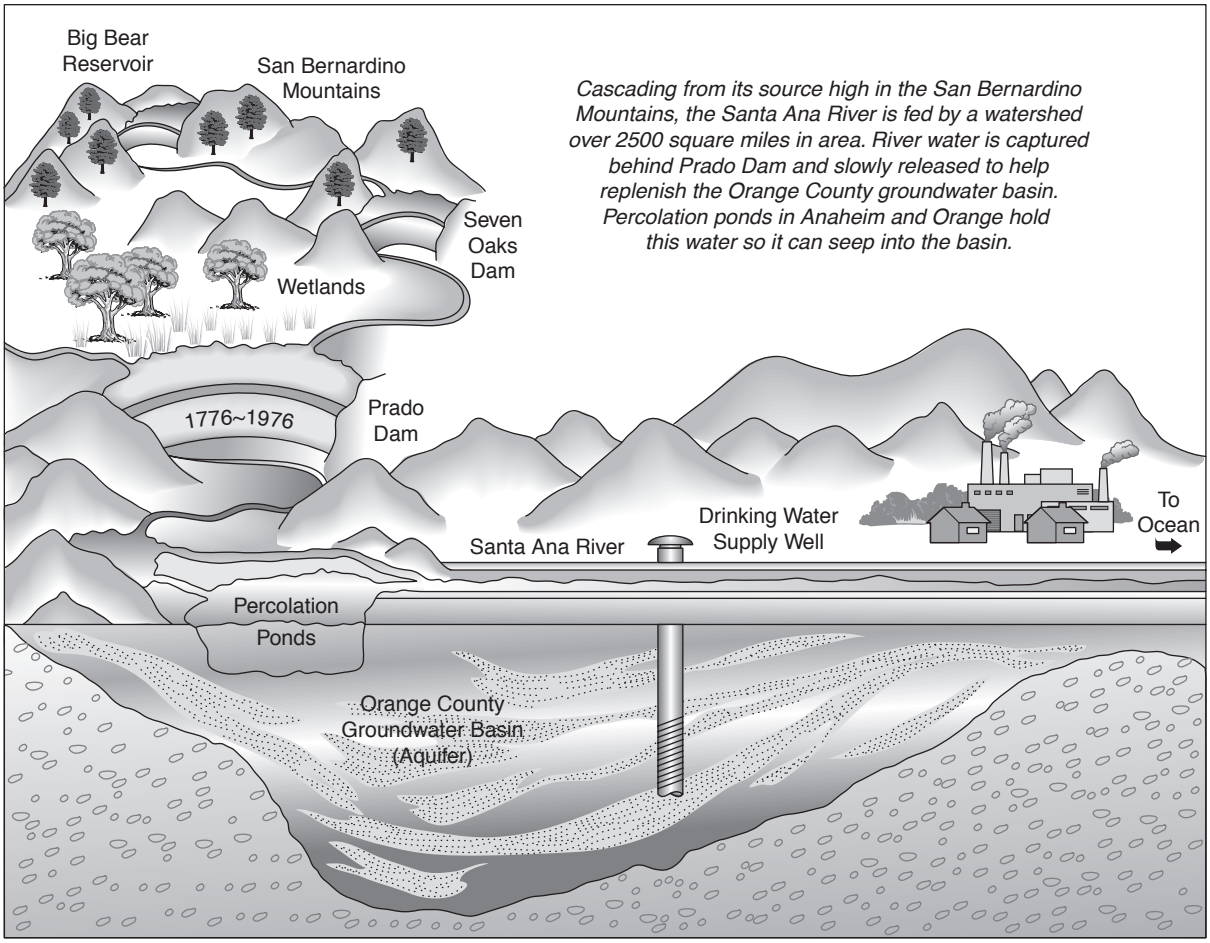

Figure 4-1 Orange County, California, water source.
Source: Southpaw Productions/Tim Hogan Design.

Contaminants that could be present in source water include:

- Microbial contaminants, which may come from many sources including sewage treatment plants and septic systems. However, the EPA has strict guidelines for coliform and *E. coli* bacteria. Furthermore, use of chlorine as a disinfectant has almost completely eliminated the risk of microbial waterborne diseases.
- Inorganic contaminants such as salts and metals.
- Radioactive contaminants.
- Pesticides and herbicides.
- Organic chemical contaminants including synthetic and volatile organic chemicals that are by-products of industrial processes and petroleum production.

The continuous monitoring of drinking water and its supply facilities that is mandated by the EPA has significantly reduced levels of these contaminants in the water supply.

Disinfection and Disinfection By-products

Chlorine is routinely used for rendering drinking water free from microbial contaminants. Federal regulations require that no more than 5% of samples collected per month can be positive for coliform

bacteria; however, in those instances where less than 40 samples are collected per month, no more than one sample can be positive for coliform. In addition, the positive sample should be tested for fecal coliform and *E. coli*, the organisms directly associated with fecal contamination. A positive level is directly associated with human health risk and, therefore, constitutes a serious MCL violation. It necessitates state and public notification along with instituting procedures for corrective action.

One drawback to chlorine decontamination, however, is trihalomethanes (THMs) and haloacetic acids (HAAs), which are the most common by-products found in drinking water treated with chlorine. These by-products could be injurious to health. Therefore, in 2006, the EPA prescribed maximum limits for THMs and HAAs that could be present in the drinking water (see Table 4-2).[12]

A second method of disinfection is to treat the water with ultraviolet light, which damages the genetic material of the microorganisms, making then incapable of reproduction. Another method is ozone disinfection. Although costly, it appears to be safer than chlorine. Ozone oxidizes most of the organic materials, thereby rendering the pathogens harmless.

Water Laws

The Clean Water Act

The federal Water Pollution Control Act, commonly known as the Clean Water Act (CWA), was passed by the U.S. Congress in 1972 to control *point source pollution*.[15,16] The EPA was required to publish and enforce waste water standards for industry and municipal sewage treatment plants. The CWA has been amended three times: in 1977; in 1981, when Congress passed the Municipal Wastewater Treatment Construction Grants Amendments; and in 1987 with the Water Quality Act. One of the provisions of the 1987 amendment was to direct individual states to develop and implement management programs specifically targeting their major *nonpoint sources.*

The Safe Drinking Water Act

The Safe Drinking Water Act (SDWA), which was passed in 1974, deals with drinking water supply regulations. This act and its subsequent amendments require the EPA to undertake many actions in order to protect drinking water, as well as its sources such as rivers, reservoirs, lakes, ground water wells, and springs, from unnecessary introduction of contaminants. The EPA was authorized to set national health-based standards for drinking water to protect against both naturally occurring and man-made contaminants that may be found in drinking water. At that time, the maximum contaminant levels (MCLs) for a number of organic, inorganic, and microbiologic contaminants were set. The EPA, states, and water system agencies were required to work together to make sure that these standards were met. Since then, this act has gone through several amendments. The 1986 amendment significantly increased the number of contaminants on the original list. It further required that a total of 83 contaminants be placed on the list by 1989 and at least 25 new contaminants every 3 years thereafter. The 1996 amendment greatly enhanced the protection of source water, thereby ensuring the quality of drinking water by protecting it from the source to the tap.

Wastewater

Wastewater is liquid waste, including storm water and sewage, that is generated during a number of activities at homes, businesses, and industries.[18] Wastewater includes sewage, kitchen, bathroom, laundry, and any water that is flushed or poured into the drain from residences, hospitals, schools, retail/wholesale stores, restaurants, and other businesses. Manufacturing wastes are generally treated as industrial wastes and are handled separately. Industrial wastewater may contain a heavy load of toxic substances and other contaminants, and therefore requires special handling permits and treatment facilities.[19]

The transport, disposal, and treatment of domestic wastewater is generally governed by and performed as part of a city's infrastructure. There are several stages in the treatment of wastewater; for example, at New York City's wastewater treatment plants, the wastewater undergoes five major processes: preliminary treatment, primary treatment, secondary treatment, disinfection, and finally sludge treatment.[20] In general in the United States, the treatments used in different cities vary depending on the quality of the effluent desired. As much as 85% to 95% of wastewater pollutants are removed by primary and secondary treatments. The effluent is then disinfected and discharged into the local waterways.

The preliminary treatment facility generally has bars 1 to 3 inches apart. The incoming wastewater flows through these bars, which catch large pieces of trash

such as rags, newspapers, soft drink cans, containers, and plastic cups. These large pieces of garbage are transported to landfills.

The wastewater from this facility is then pumped into sedimentation or setting tanks for 1 to 2 hours. This is the primary treatment stage. At this point the flow of influent water is slowed down so that the heavier solids settle at the bottom of the tank and the lighter ones float to the top and are skimmed from the tank's surface. The settled solids, called primary sludge, are passed through degritters to remove grits, which are washed and then taken to landfills. The degritted primary sludge is then pumped to sludge handling facilities, where it mixes with the sludge obtained from the secondary treatment facilities for further processing. The effluent from the primary settling tank is then sent for secondary treatment.

The secondary treatment utilizes aerobic microorganisms that grow and multiply in the presence of oxygen, and thereby remove dissolved organic nutrients. In this part of the treatment program, air and "seed" sludge are added to the wastewater to break down the organic pollutants. Wastewater passes through bubbling tanks for 3 to 6 hours. The aerated water passes to the final secondary settling tanks where heavier particles settle down as secondary sludge. This is then mixed with the primary sludge and sent to the sludge processing facility. The sludge obtained from primary and secondary treatment is processed further in thickening tanks for 24 hours. The thickened sludge remains in oxygen-free tanks, called digesters, for 15 to 20 days at 95°F. Anaerobic bacteria will digest and stabilize the sludge, and produce carbon dioxide and methane gas and some water. The digested sludge is then pumped to the dewatering facilities. The dewatered sludge is now a dry powdery cake-like material called a biosolid. These biosolids are ready to be used as fertilizers or soil conditioners in parkland, farmland, lawns, golf courses, and many similar areas.

The effluent wastewater passes through settling tanks in 2 to 3 hours and then moves on to disinfection tanks, where it remains in contact with sodium hypochlorite for a minimum of 15 to 20 minutes to destroy harmful pathogens. The treated wastewater is then released into local waterways.

If tertiary treatment is used, the majority of the residual substances, organic material, nutrients, and other substances that were not removed during the secondary treatment process are removed. The tertiary treatment can include several procedures like gas exchange, coagulation using aluminum sulfate, flocculation, sedimentation filtration, ion exchange, activated carbon adsorption, reverse osmosis, freeze-thaw, electrodialysis, and distillation. Different procedures also are required to remove nitrogen and phosphorus.

Conclusion

Proper management of our waterways, sewage transport, and treatment facilities is the goal of the EPA and state and local governmental agencies. Routine testing and monitoring of water supplies have been important tools for maintaining the level of contaminants within the prescribed guidelines. However, additional guidelines may still be needed where wastewater is to be used directly for potable purposes.

SOLID WASTE

Solid wastes are generated during various types of human endeavor and activities. The Resource Conservation and Recovery Act (RCRA), subtitle D, deals with nonhazardous wastes including municipal wastes. The RCRA considers a material as a waste if it follows certain criteria of being a waste. The definition of solid waste is not based upon the physical appearance of the material—whether or not it is solid as opposed to liquid or gas. RCRA § 1004(27) defines solid waste as:

> Any garbage, refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility, and other discarded material, including solid, liquid, semisolid or contained gaseous material, resulting from industrial, commercial, mining, and agricultural operations and from community activities.[21]

The following generate the majority of solid waste:

- *Agricultural operations:* These are the largest group of solid waste generators requiring proper disposal. Some of the examples of the wastes being created include crop residues, fruit peelings, nut shells, manure, tree trimmings, and twigs. Disposal of these wastes does not pose a significant problem because these could be used as animal fodder, energy source, or mulch. In some communities in other countries manure is used to generate methane gas.
- *Mining:* Mining of coal, phosphate, and various types of minerals including iron, lead, silver, and zinc generates solid waste. The mined area

becomes quite unsightly. At one time, shale oil mining was very popular. The shale rock was heated to liquefy oil; however, the expansion of the heated rock produced a "popcorn effect," leading to a significant disposal problem besides being unsightly in appearance.

- *Industrial operations:* Various industrial operations produce solid wastes. Moreover, many industrial operations also produce hazardous wastes, which may be harmful to nearby inhabitants and to the environment. In these situations, solid waste is separated from hazardous wastes, which are transported and processed differently.
- *Municipal use:* These are the wastes generated by individuals, households, businesses, and various types of facilities and institutions. Municipal solid waste (MSW) includes paper and paperboard, glass, tires, rubbers, food wastes, metals, plastics, yard trimmings, and appliances.[22] These constitute 5% of all wastes generated in the United States. In 2007, 254 million tons of MSW (commonly known as trash or garbage) were generated in the United States.[23]

Waste Handling and Transport

Waste management involves waste handling, collection, transport, and proper disposal of waste materials. In general, when properly managed, MSW will not pose any threat to human health or the environment.

The purpose of waste management is to collect, transport, and dispose of the wastes within a short period of time involving the least financial burden possible. Another goal is to maintain a clean environment without any negative effects on the health of the residents of the area where the wastes are being processed or disposed.

Waste disposal programs vary from community to community and also in the type of waste that is being generated in those communities. In the United States, curbside collection is the most common method of waste collection and transport. In many regions, recyclable and agricultural wastes are collected and transported separately.

Communities utilize a variety of methods to manage and dispose of MSW. At this time, a cost-effective and environmentally sound waste management program is to follow the EPA's advice and preferences in the following order: source reduction first, recycling and composting second, and disposal in landfills or waste combustors the last.

The following sections discuss the most common methods of municipal waste management.[23]

Sanitary Landfill

This is the most common and economical method of MSW management worldwide. The number of landfills in the United States has remained constant since 2006, when approximately 138 million tons of materials were discarded in landfills in the United States. The collected waste is placed in large pits and thereafter compacted into thin layers by bulldozers. After the compacted materials are 8 to 10 feet deep, they are covered with a small layer of dirt and soil, usually 6 inches deep, and compacted again. The process is continued until the landfill has attained the desired depth, at which point the entire surface area is covered with 2 feet of soil. The land also sometimes may be set up so it can be used for development of recreational facilities like a golf course or a park.

Modern landfills are constructed using a number of safeguards; for example, they may have clay or plastic lining in order to contain liquid that can form and leach into underground water supplies and a number of pipes to vent greenhouse gases before they diffuse into the ground or cause an explosion.

A number of problems can occur in landfill areas. For example, uneven settling of the land may take place, thereby making it unsuitable for any future activity. Anaerobic bacterial decomposition may take place, leading to significant emissions of greenhouse gases such as carbon dioxide and methane. Many new landfills collect potentially harmful landfill gas emissions and convert it into energy.[24] Finally, landfilling uses a lot of space that eventually may become a useless wasteland.

Incineration

Incineration of MSW is a desirable modality in areas where suitable sites for landfills are not available. This process usually reduces the volume of combustibles by about 80% to 90%. The microbiologic agents that may be present in the waste materials are completely destroyed during this procedure. This is the reason it is a desired method of disposal for biomedical waste.

This method usually leads to the formation of heat, steam, gas, and ash. The heat or steam produced can

frequently be used to perform other operations requiring energy. The ash is routinely tested to ensure that it is nonhazardous before being landfilled. Sometimes the ash is used to cover landfills and in road construction. Some of the MSW can be directly combusted in waste-to-energy facilities to generate electricity. Incineration facilities can also convert water into steam to fuel heating systems.

Over one fifth of MSW incinerators use refuse-derived fuel (RDF). RDF facilities can recover recyclables like metals, cans, and glass and then shred or break the combustible fraction into fluff for incineration. Furthermore, an incineration facility could be easily located within an urban community.

However, incineration sometimes results in air and ash emissions, which are toxic, and therefore, require proper management.[25] The characteristics of wastes fed into an incinerator have a significant effect on the quality of emissions, combustion and energy recovery, and the quantity and toxicity of ash produced.[26] Emission control devices used in the incinerators can make up for any increases in pollutant precursors in the waste stream; thus, all or most of the increase would become ash.[27]

Resource Conservation

An EPA motto supports reducing, reusing, and recycling, the so-called "3Rs."[28] The reduce and reuse areas focus on minimizing MSW; recycling relates to recovering the original material from the waste product.

Resource recovery also relates to material conversion and energy recovery. Material conversion means to produce something different from the original product present in the waste; one example is the production of "glasphalt." Glass that would have been sent to landfills is crushed into fine particles and mixed with asphalt to make glasphalt, which can be used in place of conventional asphalt. Energy recovery applies to the process of capturing the heat values of organic wastes, either by direct combustion or by converting solid wastes by heating them in the absence of oxygen to produce liquid or gaseous fuels.

Recycling is a way to produce valuable products from materials that otherwise would have been discarded and disposed of as wastes. In 2006, 82 million tons of MSW were recycled in the United States, thereby providing a reduction of approximately 50 million tons of carbon emissions. There are numerous ecological and financial benefits associated with this program of waste disposal. The recycling rate of MSW in 2007 was 1.54 pounds per person per day, an increase of 0.6% from 2006 to 2007. It has been noticed that the state of the economy has a strong impact on consumption and waste generation—they increase during times of strong economic growth and decrease during times of economic decline.

The benefits of recycling include:

- Protects and increases jobs within the country
- Decreases the need for landfill and incineration of MSW
- Saves energy
- Decreases emissions of greenhouse gases
- Conserves natural resources like water and minerals
- Minimizes the risk to the environment and human health
- Cleaner land, water, and ecology

There are three steps to recycling[29]:

1. *Collection and processing:* This step entails collecting and sorting the recyclable waste materials. The process of collection varies from community to community, but essentially there can be curbside collection, drop-off centers, buy-back centers, and deposit/refund programs. Once collected the recyclable materials are sent to a material recovery facility for sorting and manufacturing into marketable products.
2. *Manufacturing:* The cleaned and separated materials are now ready to be processed. A variety of products can be manufactured from recycled material. A number of household items like newspapers, printer paper, paper towels, aluminum cans, plastic and glass soft drink containers, and plastic laundry detergent bottles contain recycled materials.
3. *Purchasing recycled products:* This is the last step of the recycling loop. Consumers who use and buy recycled products play an important role in making recycling programs a successful venture.

Source Reduction

This relates to the reduce and reuse portions of the EPA's 3Rs. Waste prevention, also known as source reduction, is practiced during this modality of waste management. We are producing more solid wastes per day now than we ever have before. Between 1960 and 2007 the amount of waste produced per person increased from 2.7 to 4.6 pounds per day.[30] Source reduction helps reduce the amount of waste produced per day,

decreases greenhouse gas production, and reduces the costs involved in waste disposal. Reusing products or materials and reducing the amount of waste produced deal with the concept of source reduction.

The following are examples of waste reduction methods:

- Substituting reusable for disposable (e.g., use cloth napkins instead of paper ones)
- Eliminating excessive packaging or using biodegradable packaging materials
- Using appliances and other products (e.g., tires, automobiles, refrigerators, televisions) that are designed to last longer

The following are some of the benefits of source reduction:

- Saves natural resources, less waste disposal.
- Reduces toxicity of wastes by using less-hazardous alternatives (e.g., cleaning products).
- Reduces costs; preventing waste leads to economic savings for communities.

Composting

Yard trimmings, food scraps, wood waste, paper, and paperboard products constitute the largest component of our trash or MSW. Yard trimmings and food residuals together constitute 24% of the U.S. municipal waste stream. The process of transforming organic matter into a useful product is called composting.[31] Composting increases landfill capacity by diverting organic materials from landfill. The process of composting involves mixing organic wastes like yard trimmings, food scraps, and manure in proper ratios and placing them in small piles or containers. Wood chips are added as bulking agents, which are required to accelerate decomposition of the organic materials. Finally, the finished material needs to fully cure and stabilize. The high temperature produced during the process tends to destroy pathogens and weed seeds. The following five variables must be controlled during composting:

- *Feedstock* (the raw material used for composting) *and nutrient balance:* This requires experimentation and patience.
- *Particle size:* Grinding and shredding increases the surface area, allowing the microorganisms to grow properly.
- *Moisture content:* Although water is present in the organic material, it may not be enough. Intentional watering can help the beneficial microorganisms grow.
- *Oxygen flow:* Turning the pile will aerate the mass and allow faster decomposition.
- *Temperature:* Optimal growth and activity of the microorganisms takes place at relatively high temperature. If the previous four factors are controlled properly, the required temperature for microbial growth will be attained.

The mineral- and nutrient-rich compost is used for a variety of activities.

- It acts as a fertilizer, enriching soils and reducing the need for water and pesticides.
- It completely eliminates wood preservatives, pesticides, and both chlorinated and nonchlorinated hydrocarbons in contaminated soils.
- It helps to clean up soils by absorbing odor and binding with heavy metals, thereby preventing their migration to water resources.
- It suppresses plant diseases and pests.
- It is a great alternative to the routine methods of cleaning contaminated soil.

Conclusion

As is evident from the foregoing, the sanitary landfill is the most common and economical method of municipal solid waste disposal. However, as the population is increasing rapidly and the land area for waste disposal is becoming scarce, the other methods are being used more often. Although we have progressed further in this respect during the last decade, we need to perform feasibility studies and make it mandatory to use those waste disposal methods that are suitable for each particular type of solid waste. This would require less land, make the environment less polluted, and maintain good community health.

HAZARDOUS WASTE

Any waste is considered to be hazardous if it contains certain amounts of toxic chemicals. These wastes are potentially harmful to human health or may have the capacity to pollute the environment. Hazardous wastes can be solids, liquids, or semi-solid materials and may contain gases and sludge. Hazardous wastes are generated from a number of industrial and nonindustrial operations and during the manufacturing of a number of products such as pharmaceuticals, cosmetics, household chemicals, pesticides, detergents, cars, and even computers.

According to the EPA, a waste is considered to be hazardous if it exhibits any of the following four characteristics (per 40 CFR Part 261 Subpart C)[32]:

- *Ignitability:* Such wastes are generally spontaneously combustible or have a flash point less than 140°F (60°C). Examples of such wastes are oils, solvents, plasticizers, and paint wastes.
- *Corrosivity:* These wastes can corrode metal containers like storage tanks, drums, and barrels, and are capable of causing damage to living tissues. Corrosive wastes are acids or bases that have a pH less than or equal to 2.0, or greater than or equal to 12.5. Battery acid is an example.
- *Reactivity:* These are unstable wastes and are capable of causing explosions. They have a great tendency to react quickly with air or water, or explode spontaneously and produce toxic fumes. Examples include firecrackers and lithium-sulfur batteries.
- *Toxicity:* These wastes produce acute and/or chronic damage to body tissues and can even be fatal when ingested or absorbed. Examples include pesticides and heavy metals (e.g., mercury, lead).

In addition to these properties, the EPA has developed a list of over 500 specific hazardous wastes.

Within the United States, the EPA and state hazardous waste enforcement agencies are responsible for the promulgation, enforcement, and implementation of hazardous waste programs and laws. Various types of small and large companies generate significant amounts of hazardous wastes. Within a given community, dry cleaners, auto repair shops, hospitals, clinical laboratories, exterminators, and photo processing centers are frequent generators of hazardous waste. Some larger companies, like chemical manufacturers, electroplating companies, and petroleum refiners, are also hazardous waste generators.

Federal Regulations Dealing with Hazardous Waste

The following are some of the most important federal regulations regarding hazardous waste:

- *Resource Conservation and Recovery Act (RCRA):* This act was enacted by Congress in 1976.[33] It is the main federal legislation dealing with solid and hazardous waste management.
- *Universal Waste Rule:* This was adopted by the EPA in 1995. It regulates various types of hazardous wastes including various types of batteries, mercury-bearing thermostats, and pesticides.
- *Comprehensive Environmental Response, Compensation and Liability Act (CERCLA):* This is also known as *Superfund*.[34] It was enacted into law by Congress in 1980. Superfund created a trust fund through a tax on the chemical and petroleum industries. The money is to be used to clean up uncontrolled or hazardous waste sites when the parties responsible for the waste cannot be located or identified. In addition, this act authorized the EPA to search for the responsible persons/parties and collect costs once cleanup of the wastes is completed. Over 5 years, $1.6 billion was collected and the tax went to a trust fund for cleaning up abandoned sites or uncontrolled hazardous waste sites.[35]
- *Superfund Amendments and Reauthorization Act (SARA):* SARA[36] was passed in 1986. This act required the EPA to revise the Hazard Ranking System (HRS) so that the extent of human health and environmental risk posed by uncontrolled hazardous waste sites could be correctly evaluated. In addition, SARA made numerous changes and additions to the Superfund program including creation of new enforcement authorities and settlement tools and increasing the size of the trust fund to $8.5 billion.

Different Methods of Hazardous Waste Disposal

The disposal of hazardous waste is much more difficult than highly regulated.

Secure Chemical Landfill

RCRA subtitle C is the federal program that manages hazardous wastes from cradle to grave. This program is under the supervision of the EPA or an approved state agency. Its major goal is to design safe storage and treatment facilities for hazardous wastes to minimize their release into the atmosphere. Its enforcement programs require that the established guidelines, rules, and regulations are properly followed and met.

The EPA has established a Land Disposal Restrictions (LDR) program, which was approved by Congress in 1984. The LDR program has developed mandatory

technology-based hazardous waste treatment standards that must be met before a hazardous waste can be placed in a landfill. This helps to minimize various ill effects to human health and the environment, and protects the community at large. Essentially, secure landfills are similar in design to sanitary landfills, except they are sturdier and have significantly thicker plastic liners.

The availability of space for secure landfills is decreasing because the residents of nearby communities do not want to have hazardous wastes disposed of near them. Various toxic effects have been observed due to shifting of the soil, cracking of the liners, or hazardous wastes getting in the leachates. A study done by Clark et al.[37] in a small community in Tennessee found the presence of high levels of carbon tetrachloride in the potable water. Leachate from a pesticide waste dump in that area may have been the source of ground water contamination. Studies conducted by Mallin[38] found a high incidence of bladder cancer in males and females in northwestern Illinois from 1950 through 1979. Subsequent studies demonstrated that chemical contamination coming from a nearby landfill may have contaminated a drinking water well that was eventually closed down.

Even though the proximity of housing complexes to various hazardous landfills has been shown to have adverse outcomes, no direct link has been pointed out.[39] Therefore, although chemical landfills are legal, they are considered the least suitable method of hazardous waste disposal.

Physical Methods

Various physical means have been used to decrease the volume of generated hazardous wastes. Typically concentration, sedimentation to remove solid from liquid wastes, and carbon adsorption to remove certain soluble organic wastes have been used. However, the residual wastes so produced are frequently hazardous and have to be properly disposed.

Chemical Methods

The majority of chemical methods of disposing of hazardous wastes involve treating them with various chemicals to render the wastes harmless; two examples of chemical methods are sulfide precipitation and conversion of hazardous wastes to nonhazardous wastes via oxidation-reduction methodologies. Sometimes hazardous wastes can be combined with organic polymers or other inert substances like silica to form solid nonhazardous wastes.

Microbiologic Treatment

Bioremediation is a cost-effective method of rendering hazardous wastes into nonhazardous by-products through the use of microorganisms, fungi, or green plants.[40] It can be used in various clean-up situations. This procedure was found to be very effective in the Exxon *Valdez* oil spill, substantially lowering costs compared with what they would have been if other methodologies were used for this clean-up.[41,42] The technique of genetic engineering has improved the process of bioremediation by producing various types of microorganisms to destroy a range of hazardous substances.

The bioremediation process has several attractive features. It can be accomplished using microbial agents that destroy toxic wastes and render them harmless, and these activities do not require as much of the space or energy that may be required in the secure landfill and incineration processes. The major products of bacterial degradation are carbon dioxide and methane gas. Methane gas, being highly flammable, is usually collected separately and is sometimes used for energy production.

Certain regulations enforced by various agencies have influenced the development of bioremediation technologies. For example, the Clean Air Act requires that coal burning plants must have lower levels of sulfur emissions than in previous years because these could produce acid rain. Microterra, a Florida-based company, has developed a technology utilizing bacteria that can reduce sulphur emissions.

Incineration

Numerous studies conducted by the EPA have concluded that incineration offers an effective and safe method of hazardous waste disposal.[43–45] Since the inception of high temperature incineration technology, organic hazardous waste disposal has been using this method, and it is becoming very popular. An incinerator can burn from 500°F to 3000°F.

A typical hazardous waste incinerator has two components: (1) a primary combustion chamber or a rotary kiln, and (2) a secondary combustion chamber or an after burner connected to an air pollution control system. The solid and liquid wastes are generally heated at or above 1800°F. High temperature converts organic and some metal wastes into hot gases. These gases are then injected into the secondary combustion chamber, where the temperature is frequently maintained at

2200°F or higher. The heat and the flame in this chamber further break down the gases into atoms. These atoms combine with the oxygen pumped into the chamber to form stable nonhazardous compounds such as water, carbon dioxide, and steam. All operations are well controlled and monitored. The ashes and residues that are left behind are analyzed for hazardous components. These should not contain more than one part per million of any organic constituent. These hazardous wastes are under EPA and state regulations.

Incineration has advantages over other hazardous waste disposal methods: (1) toxic compounds can be rendered harmless; (2) waste volume is significantly reduced; (3) residues can be treated effectively and disposed of safely; (4) it provides a potential source of energy recovery during combustion of wastes; and (5) there is no future problem of storing hazardous wastes.

Hazardous Waste Recycling

Recycling is an ideal way to manage and reuse hazardous industrial wastes and eliminate costly and significant disposal problems. With this method, hazardous wastes are recycled by another industry to generate products or energy for their particular activities, thereby reducing disposal costs and the quantity of waste. So-called "waste exchanges" act as third parties, matching up waste generators and recyclers for their industrial operations. Waste generators using this option can avoid the high cost of hazardous waste disposal by providing these wastes to another company, which in turn can use these as a source of raw material for their industry. It is a profitable situation for both the waste generator and the waste recycler. Recycling regulations have been developed by EPA to promote the reuse and reclamation of useful materials in a manner that is safe and protective of human health and the environment.[46]

Deep Well Injection

Deep well injection is used to dispose of liquid wastes. The treated and untreated liquid wastes are injected into wells in certain areas of the ground where they could not seep into potential water aquifers. The hazardous waste is injected through an impervious casing that extends below the base of any underground drinking water source. The entire system is sealed at the bottom by a removable packer, preventing injected wastewater from backing up into the string casing and the injection tube, called the annulus. However, certain requirements must be followed when this method of waste disposal is used; for example, injection cannot be used for hazardous waste disposal in those areas where seismic activity is likely to occur.[47]

Conclusion

In summary, although there are several efficient, effective, and useful methods of hazardous waste management, there is still a need for a well-defined, effective, and feasible method that can work for a variety of hazardous wastes. At times, hazardous wastes need to be transported several hundred miles before they can be disposed of properly. We need facilities and efficient hazardous waste disposal programs that can work in an essentially similar manner in several regions of this country.

The EPA has provided numerous research grants on the handling and management of hazardous waste, including development of in-situ biodegradation technology, air injection and remediation of groundwater,[48] and development, characterization, and evaluation of adsorbent regeneration processes for treatment of hazardous waste.[49] Therefore, it appears the EPA may approve more efficient and effective hazardous waste management programs in the near future.

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CHAPTER 5

Food and Nutrition

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CHAPTER OUTLINE

INTRODUCTION

Dietary nutrients affect every organ, every cell, every system, and every biochemical pathway in the human body. Low levels or lack of even one vitamin can cause early death. Our need for, use, and excretion of nutrients change minute by minute and are under the control of hormones, enzymes, drugs, stress, age, exercise level, body size, and environmental factors. For this book, I've chosen a few items emphasized in the Healthy People program that are identified and tracked: iron deficiency and anemia, folic acid deficiency and neural tube defects,

and obesity and the relationship to sweeteners and junk food consumption. Two other nutritional components I discuss in this chapter are just starting to be seen as public health issues and have early or no tracking (epidemiologic) system in place: trans fats and their relationship to disease and the emerging resurgence of vitamin D deficiencies. One public health decision will be revisited in this chapter with updated information and concerns: the need for fluoridation of water and other beverages. Other equally deserving topics will not be discussed in this chapter, but have been addressed in public health policy statements, including mercury in fish, calcium and osteoporosis, fiber and heart disease, and sodium and hypertension.

Some nutrient deficiencies have resulted in such obvious morbidity that the federal government intervened by adding them into food: iodine in salt to prevent goiters, vitamin D in milk to prevent rickets, folic acid in cereal grain products to decrease neural tube defects, and the omega-3 fatty acid docosahexaenoic acid (DHA) added to infant formula for brain development.

Because of on-going public outcry, local governments recently have been making nutrition policies on behalf of their communities to stem the escalating morbidity from obesity and heart disease. More and more city and state governments are restricting the use of trans fats and requiring fast food outlets to prominently display caloric content. Other diseases, such as obesity, diabetes, heart disease, many cancers, and many neurological conditions, are nutritionally related, but are so complex that a single nutrient intervention will not suffice. These will be addressed peripherally in this chapter under trans fats, sweeteners, fast foods, and obesity.

IRON DEFICIENCY AND ITS RELATED ANEMIA

The Deputy Executive Director of UNICEF stated that

> vitamin and mineral deficiency is the source of the most massive "hidden hunger" and malnutrition in the world today. The "hidden hunger" due to micronutrient deficiency does not produce hunger as we know it. You might not feel it in the belly, but it strikes at the core of your health and vitality. It remains widespread, posing devastating threats to health, education, economic growth and to human dignity.[1]

The Centers for Disease Control and Prevention (CDC) and the U.S. Department of Agriculture (USDA) have estimated that 18% of pediatric patients have two or more indices indicating nutritional deficiencies. Seventy-five percent of children receive between 50% and 80% of the Recommended Daily Allowance on the U.S. Healthy Eating Index.[2]

Iron deficiency is the most common nutritional deficiency in the world and remains common in at-risk groups in the United States.[3,4] *Iron deficiency anemia* is the most severe consequence of iron depletion[5]; however, most children in developed countries who have an iron deficiency do not have anemia.[6]

The Healthy People program includes reduction of incidence of iron deficiency in children and females of childbearing age as one of its nutritional goals.[7] Children are at great risk for iron deficiency due to their increased needs and decreased intake. An iron-deficient diet is one of the top causes of iron deficiency.

Epidemiology

According to the National Health and Nutrition Examination Survey II–IV (NHANES 1976–2002), there has been no improvement in iron deficiency prevalence over the past 26 years.[8] Iron deficiency remains above the 2010 objectives of 5%, 1%, and 7% for toddlers, preschool children, and females ages 12–49 years, respectively. Among minority females ages 12–49 years, the prevalence of iron deficiency was approximately three times greater than the 2010 national health objectives.[7] Iron deficiency ranges from 6% to 18% in various subpopulations of toddlers and young women.[6,9] Anemia due to iron deficiency was found in 2% to 5% of these. This percentage "corresponds to approximately 700,000 toddlers and 7.8 million women with iron deficiency and approximately 240,000 toddlers and 3.3 million women with iron deficiency anemia. Iron deficiency occurred in no more than 7% of older children or those older than 50 years, and in no more than 1% of teenage boys and young men."[9] "The prevalence of iron deficiency anemia is 2% in adult men, 9% to 12% in non-Hispanic White women, and nearly 20% in African American and Mexican American women.[10] According to the National Institutes of Health, 50% of all pregnant women have iron deficiency anemia."[4] About 2.7% of healthy postmenopausal women ages 44–69 years old are iron deficient.[11]

About 18% of low-income children have iron deficiency anemia severe enough to require medical treatment, especially when their families do not receive food stamps.[12,13] Providing food stamps through the Women, Infants, and Children (WIC) program decreases the incidence of iron deficiency and anemia, and

improves growth outcomes of children.[14] In children, the most common time for iron deficiency is between 9 and 24 months of age.[3] Eleven to thirty-five percent of 12- to 36-month-old toddlers from WIC clinics had some type of anemia. Iron deficiency anemia occurred in 3% to 8%. Iron deficiency without anemia was present in 7% to 16%. Borderline iron deficiency was present in 25% to 29%.[3,15,16]

Labs

Iron deficiency may develop soon after cessation of adequate iron intake. Anemia secondary to iron deficiency develops gradually over a period of several weeks to months.[17] The Institute of Medicine and the CDC recommend that blood test screening for iron deficiency anemia first be targeted to children identified by dietary and health history, because of the costs and inconvenience associated with blood test screening.[14] However, in a high risk population of children neither individual nor combinations of parental answers to dietary and health questions were able to predict iron deficiency anemia, anemia, or iron deficiency well enough to serve as a first-stage screening test.[16] In a study of 6- to 12-month-old infants, there were no conclusive physiologic predictors of iron deficiency or anemia.[18]

The American Academy of Pediatrics (AAP) recommends serum screening for anemia between the ages of 9 and 12 months, with additional screening between the ages of 1 and 5 years for patients at risk. Some recommend universal screening for anemia during the second year of life and at age 1 year or before for at-risk children.[17,19] The U.S. Preventive Services Task Force currently recommends routine screening for iron deficiency anemia in pregnant women, but not in other groups of teens and adults.[10]

"*Serum ferritin* is the most sensitive indicator of low iron and is the preferred initial diagnostic test for iron deficiency.[6,20] Total iron-binding capacity, transferrin saturation, serum iron, and serum transferrin receptor levels may be helpful."[3,10,14] The Healthy People program defines iron deficiency as an abnormal result on at least two of the following tests: serum ferritin concentration, erythrocyte protoporphyrin, and transferrin saturation.[7]

In iron deficiency anemia, stored iron declines until iron delivery to the bone marrow is insufficient for erythropoiesis. Low red blood cell hemoglobin (Hb) content occurs last and defines *microcytic, hypochromic anemia*.[15] According to the AAP, the use of hemoglobin as a screening test is of little value because it fails to identify patients who are iron-deficient but are not anemic.[3,17] The current detection strategy of using hemoglobin needlessly treats and retests many children without iron deficiency and leaves many iron-deficient toddlers unattended.[6]

A positive screening test is an indication for a therapeutic trial of iron, which remains the definitive method of establishing a diagnosis of iron deficiency.[19] When adequate dietary iron is provided, these markers return to normal, indicating a response to the dietary supplement.[21] In one study, 72% of children determined to be anemic were prescribed iron; after 6 months, 71% of the anemia cases resolved due to supplementation or other factors.[15] Even with adequate early diagnosis and supplementation, follow-up in children of low income or low education is poor. In one study of over 300 children with anemia, only 5% to 7% returned within 1 month and 37% to 42% did not return 6 months after diagnosis.[15] If the hemoglobin levels do not increase after 1 month of iron supplementation, the patient needs to be evaluated for other underlying causes.

Other Causes of Iron Deficiency

Other causes of iron deficiency and anemia include hemorrhagic conditions, such as heavy menstrual losses,[22] gastrointestinal bleeding,[23] colorectal cancer, bowel lesions and bowel surgery,[24] end stage renal disease, intake of aspirin and other bowel irritants, malabsorption syndromes, inadequate hydrochloric acid, chronic inflammatory disease,[21] presence of intestinal parasites,[25] some forms of vegetarianism, fad or weight loss diets, overweight and obesity,[8,26,27] pregnancy and lactation,[27] poverty, and starvation or lack of adequate food availability. Some endurance athletes (long-distance runners) may lose blood/iron after rigorous training or an event.[28,29] Elderly men in a resistance training programs tended towards lower serum ferritin levels during training and improved when iron-rich foods were increased.[30] For those over age 50, a colonoscopy followed by an endoscopic evaluation is recommended because 9% of patients older than 65 years with iron deficiency anemia have a gastrointestinal cancer when evaluated.[10]

Dietary Causes of Iron Deficiency

Intervention should focus on the primary prevention of iron deficiency through diet and supplementation. Pregnant women who are iron deficient and drink more than two glasses of juice per day tend to bear infants with iron deficiency.[16] Very small preterm

infants have an increased requirement for dietary iron. One study found that using fortified infant formulas added to mother's expressed milk decreased the need for blood transfusions due to anemia.[31] Children need to absorb about 1 mg of iron daily to keep up with growth needs. This means that most children need to eat 8–10 mg of iron daily because only 10% is absorbed. Breast-fed babies need less, however, because iron is absorbed three times better in human breast milk.[32]

In the first year of life, measures to prevent iron deficiency include prolonged breastfeeding,[33] use of iron-fortified milk formulas,[34] and completely avoiding cow's milk. Iron deficiency tends to occur as the child is weaned from mother's breast milk or fortified infant formulas. Too much cow's milk is a classic cause of iron deficiency because cow's milk has no iron and inhibits absorption of iron.[32,35]

Routine iron supplementation is recommended from about 4 to 12 months of age in high risk groups,[10] and after weaning.[34] Use iron plus vitamin C–fortified weaning foods starting at about 6 months of age. In the United States, all infant formulas and cereals and most bread and pastry products are enriched with iron.[33,34] In the second year of life, iron deficiency can be prevented by eating a diversified diet that is rich in sources of iron and vitamin C; limiting soy, cow, and goat milk consumption to less than 24 ounces per day; and providing daily iron-fortified foods or a multivitamin/mineral supplement.[19,33,36,37]

The type of fruit juice a child receives also may increase their risk for iron deficiency. Polyphenolics naturally present in red or purple grape juice and prune juice profoundly inhibit absorption of iron. Some juices for children have been fortified with iron.[38] Also, iron status is better in children who consume orange or tomato juices. In older children and adults, increasing the amount of red meat consumed generally, but not always, improves serum ferritin levels compared to eating fish, fowl, dairy, or eggs.[22,39] Fruit, alcohol, vitamin C, and iron supplementation have been positively correlated with higher iron status in adults. Coffee intake, however, decreases iron status.[39,40]

Iron and zinc share common food sources, and children at risk of iron deficiency may also develop zinc deficiency. Forty-three percent of children ages 12 to 36 months recruited from a WIC program were zinc deficient.[41] Animal protein foods contain high amounts of zinc. Reports have shown that adolescents consuming protein foods had adequate zinc status.[30,42]

Signs, Symptoms, and Diseases Related to Iron Deficiency

Adequate bioavailable iron intake is essential for optimal growth and intellectual development of infants and children. Iron deficiency during childhood results in decreased appetite and growth retardation. As iron levels decrease, there is less *ghrelin*, a gastric hormone that increases appetite. A decrease in ghrelin levels in iron deficiency anemia can lead to loss of appetite and an increase in pica or the consumption of non-nutritive items, such as paint chips.[43]

The main symptom of iron deficiency is mild to severe fatigue and weakness.[4] Severe iron deficiency anemia can affect the heart. The heart has to work harder to get enough oxygen throughout the body. In young children, this can cause a heart murmur. Over time, this stress on the heart can lead to a fast or irregular heartbeat, chest pain, an enlarged heart, and even heart failure.[4]

Children and adolescents with iron deficiency are more likely to have learning problems, impaired cognition, and psychomotor, developmental, and behavioral disorders. There is an increased risk for *attention-deficit/hyperactivity disorder* (*ADHD)* and lead poisoning.[17,34,44] Iron deficiency causes abnormal dopaminergic neurotransmission and may contribute to the development of ADHD.[44] Serum ferritin levels are often low in children with ADHD. One study found 84% of those with ADHD, compared to 18% of controls, had a low serum ferritin level.[44] In ADHD children, lower ferritin levels were associated with higher hyperactivity, greater cognitive deficits, and more severe behavioral problems based on parental and teacher ratings.[44–46] After 12 weeks of 80 mg/day oral ferrous sulfate, there was significant improvement in ADHD rating scores in non-anemic, iron-deficient children with diagnosed ADHD. The iron therapy was well tolerated and its effectiveness was comparable to prescription stimulants.[47] Cognitive and motor development deficits observed in iron-deficient or anemic children improved with long, low dose iron supplementation.[48] Poorer developmental functioning appears to persist. The success of intervention relies on early identification of iron deficiency with appropriate restoration of iron levels.[19]

In adults, iron deficiency anemia can result in a wide variety of adverse outcomes including diminished work or exercise capacity, impaired thermoregulation, immune dysfunction, gastrointestinal disturbances, and neurocognitive impairment. In addition, iron deficiency anemia concomitant with chronic kidney disease or congestive heart failure can worsen the outcome of both conditions.[5] Iron deficiency during pregnancy increases

the risk for premature delivery, stillbirth, low birth weight infants, and impaired immune response.[4,49]

Concerns Regarding Universal Iron Supplementation

Recommendations for dietary iron intake at different life stages have been provided by the U.S. Food and Nutrition Board (FNB), the UN Food and Agriculture Organization (FAO), the World Health Organization (WHO), and the European Union Scientific Committee, among others. Interpretation of estimates leads to different recommendations by the different panels.[49]

Although iron supplementation of those with iron deficiency and iron deficiency anemia is beneficial, recent studies suggest that this may not be the case for those with adequate iron status. Despite much research, there are many areas of uncertainty regarding iron supplementation of infants including the optimum amount, the optimal age for intervention, and the optimal source of iron. In immature infants, regulation of iron transporters may explain the adverse effects of iron supplementation.[50] In adults there is risk for iron overload with low consumption of dairy products and eggs, which inhibit iron absorption, and a high consumption of alcohol, meat, and poultry containing heme iron, which enhance iron absorption.[51] It seems prudent to use the lowest dose of iron that prevents iron deficiency.[33]

Iron and the other trace minerals are not safe at higher doses. Supplementation of four times the RDA significantly increases body stores of iron.[52] According to Jean Mayer of the USDA Human Nutrition Research Center on Aging, high body iron stores may increase the risk of several chronic diseases.[39,40] Giving iron to those without need can impair growth in children and increase the risk for heart disease, atherosclerosis, cancer, intestinal damage, growth of bacteria, and oxidative damage and its related diseases. The body does not compensate for the iron overload by increasing excretion.[49,53] Interactions among iron and other vitamins and minerals need to be considered when evaluating the effects of iron supplementation on infants and children.[50,54] Iron supplementation, especially when given with folic acid, appears to lead to higher mortality in children with malaria and certain bacterial diseases.[55]

Public Health Intervention Recommendations for Iron Deficiency and Its Anemia

It seems most reasonable to identify those at risk, do reliable tests, supplement and modify the diet, and retest later.[56] Supplement users should be made aware of the amount of iron necessary to satisfy dietary requirements and informed of the possible influence that excess iron intake can have on body iron stores and health.[52]

FOLIC ACID DEFICIENCY: RELATED DISEASES AND RISK FACTORS

Folic acid deficiencies are related to many significant diseases, and large groups in the population are *folic acid deficient*. Folic acid deficiencies elevate levels of *homocysteine*, which is a separate risk factor for the development of cardiovascular diseases, Alzheimer's and other dementias, some cancers, and some miscarriages.

Folic acid deficiency has been linked with *neural tube defects (NTDs)* in the unborn when the mother is deficient during the first 6 to 8 weeks of gestation. Neural tube defects cause deformities of the brain and spine. Because of this, the Healthy People program has made lowering the incidence of neural tube defects a nutritional priority. Enriching cereals and breads with folic acid since 1998 has helped decrease the incidence of defects, but many young women still get inadequate amounts, putting their pregnancy at risk.

A high level of homocysteine is related to the incidence of neural tube defects, miscarriage, heart disease, colorectal cancer, kidney disease,[57] Alzheimer's disease, and other *methylation defect* disorders. Some people have genetic and enzyme defects in which they cannot convert dietary folic acid into the biologically active form. Because numerous genes may be involved, it is unclear of the impact this has on disease incidence.

Neural Tube Defects

Prior to 1998, several studies indicated that at the time of conception only 21% to 32% of women were getting optimal folic acid of at least 400 micrograms per day from food or supplements. Younger age, smoking, Mexican American ethnicity, and low educational level were significant predictors of failure to use folic acid both before and during pregnancy. Only 28% of women with some college education took adequate daily folic acid.[58,59] Median red blood cell (RBC) folate levels among nonpregnant women of childbearing age were 160 μg/mL. The Healthy People goal for 2010 is to have 80% of women with adequate consumption and a serum RBC folate of 220 μg/mL.[60] Red cell folate levels higher than 906 μmol/L (400 μg/mL) may be optimal for the prevention of folate-responsive neural tube defects.

The fortification of refined grain foods with folic acid was mandated by the U.S. Food and Drug Administration (FDA) in 1998. This was expected to deliver about 100 micrograms per day. Within a couple years of fortification, the incidence of spina bifida and other neural tube defects decreased by 50%.[59] The actual numbers of cases declined from 6/10,000 live births to 3/10,000 live births, or 3000–4000 infants annually. In the United States, the total cost of spina bifida over a lifetime for affected infants born in 1988 was almost $500 million, or $294,000 per infant.[59,61]

After fortification, bread, rolls, and crackers became the largest contributor of total folate to the American diet, contributing 16% of total intake, surpassing vegetables, which were the number one folate food source prior to fortification.[62] Folic acid fortification of grains led to significant increases in both serum and RBC folate concentrations. Even with fortification, however, less than 10% of women of childbearing age reached the recommended RBC folate concentration needed to significantly reduce neural tube defects risk.[62] After a post-fortification high, folate intake decreased during the early 2000s, most likely due to the popularity of low carbohydrate diets. The incidence of neural tube defects was predicted to increase 4–7%. The number of women consuming >1 mg bioavailable folate per day decreased.[63] Avoiding folic acid–fortified foods removed 78 micrograms of folic acid per day from the diet, with a concurrent drop in red blood cell folate concentrations.[64]

Relying on fortified cereal and grain products is not adequate, however. Women should be taking a supplement. Taking a folate supplement of 450 micrograms per day or higher results in reaching the protective levels of red cell folate. It would take more than 500 micrograms of folate per day from foods and fortified cereals to attain the desired RBC levels.[65] Many public agencies have disseminated the information that all women of childbearing age need to supplement with 400 micrograms of folic acid daily.[66] Current studies indicate that many pregnant women still get inadequate amounts. A 2003–2007 study indicated that those ages 18–24 years had the least awareness regarding folic acid consumption (61%), the least knowledge regarding when folic acid should be taken (6%), and the lowest reported daily use of supplements containing folic acid (30%). This age group accounts for nearly one third of all births in the United States.[67] During the first trimester visit, 11% of women were deficient and 13% were classified as intermediate. Serum homocysteine was elevated in many women with low folic acid levels.[68] Most women who had a neural tube defect–affected pregnancy were unaware of the national folic acid recommendations and did not follow these recommendations for subsequent pregnancies.[69]

According to the Society of Obstetricians and Gynecologists of Canada, it is unlikely that diet alone can provide levels similar to folate multivitamin supplementation. For many groups of women, 400 micrograms a day is inadequate. Many will need up to 5 mg folic acid daily beginning at least 3 months before their pregnancy and continuing through the first trimester. They recommend increasing the level of national folic acid flour fortification to 300 mg/100 g (the present level is 140 mg/100 g).[70]

Folic acid fortification in foods also reduces the severity of neural tube defects when they do occur. This presents other public health issues as these children with birth defects survive.[71]

The Homocysteine Link with Folic Acid

Homocysteine, a metabolite from the amino acid methionine, appears to damage a variety of tissues when it is chronically elevated. In the two normal pathways, homocysteine is broken down for use in the mitochondria or to make more methionine. Both pathways require several B vitamins, including the biologically activated form of folic acid, tetrahydrofolate. A deficiency of folic acid and the other B vitamins (B_6, B_{12}, betaine, and dimethylglycine) can lead to homocysteine elevation and increased incidence of related conditions.

Elevated homocysteine levels above 15 μg/dL are accepted as an independent risk factor for cardiovascular disease.[72] The prevalence of hyperhomocysteinemia in the general population is between 5% and 10%, and may be as high as 30–40% in the elderly population. Elevated homocysteine levels may be responsible for up to 10% of cardiovascular events, and thus may represent an important and potentially modifiable risk factor for cardiovascular disease.[73]

Because public screening for elevated homocysteine is too costly, the Canadian Task Force on Preventive Health Care encourages the daily intake of supplemental and dietary sources of folate, B_{12}, and B_6 to decrease the incidence of cardiovascular disease.[73] An adequate intake of at least 400 micrograms of folate per day from food is difficult to maintain even with a balanced diet, and high-risk groups often find it impossible to meet these folate requirements. Supplementation is inexpensive, potentially effective, and devoid of adverse effects and, therefore, has an exceptionally favorable benefit/risk ratio.[74]

The Genetic Link with Folic Acid

Folic acid affects DNA synthesis, amino acid metabolism, and methylation of genes, proteins, and lipids. *Gene mutations* can affect the biochemical pathways and cell receptors, leading to elevated serum and urine homocysteine. Neural tube defects are associated with an inability to convert homocysteine to methionine due to folate deficiency and to the mutation within the methylenetetrahydrofolate reductase (MTHFR) gene. Low maternal RBC folate levels are related to fetal death due to neural tube defects. RBC folate levels are depressed in the presence of the MTHFR gene variant and increase the risk for neural tube defects.[75]

Normal subjects who are homozygous for the specific gene mutation have significantly decreased RBC folate. The prevalence of that genotype is significantly higher among children with spina bifida and their parents.[76,77] Significantly low levels of RBC folate were found in the mothers with these genetic defects. Folate deficiency and an unfavorable genotype in mothers are important risk factors for severe neural tube defects.[78] Adding additional folic acid in fortified foods and as supplements can negate some of the adverse outcomes of gene expression. For example, women with neural tube defect–affected pregnancies have been reported to have high autoantibody titers against the folate receptor. Elevated homocysteine increases the production of autoantibodies. The embryo then becomes folic acid deficient.[57,79]

Public Health Intervention Recommendations

At this time, it is too costly to screen the population or even small segments of the population (i.e., pregnant women) for genetic and enzymatic defects and for blood and urine homocysteine levels. Homocysteine evaluation could feasibly be done on those with many risk factors for heart or kidney disease, those with sequential miscarriages or who have birthed a child with a neural tube defect, and those who have already been diagnosed with related diseases. Insurance providers seldom reimburse for this test, however. The following are feasible public health interventions:

- Educate the public (family, patients, students) about the importance of eating foods rich in folic acid. Provide lists of foods and the amount of folic acid provided. To enhance compliance, provide recipes or ideas on how to prepare simple and tasty dishes.
- Emphasize the importance of daily dietary supplementation, especially in the at-risk group. A supplement is best taken as a multivitamin because there are many cofactors that can influence folate status. Supplements should provide between 400 and 1000 μg of folate per tablet.
- Sexually active women of childbearing age and those trying to get pregnant should start taking supplements a minimum of 3 months before conception for best results. *Prenatal supplements* contain adequate folic acid and can be used prior to conception.
- Measure serum RBC folate levels in those with poor dietary or supplemental intake and those at high risk. In the deficient group, larger amounts of supplementation may be required until tissue levels elevate. Up to 5 mg a day are considered safe. Nausea can occur at this level, however, so the supplement should be taken in smaller increments throughout the day. If the folate levels do not improve with supplement intervention, switch to a bioactive form of supplemental tetrahydrofolate. These are sold by several reliable nutrition companies.

RICKETS AND OTHER VITAMIN D-RELATED DISORDERS

The epidemic of rickets in the 19th century was caused by vitamin D deficiency due to inadequate sun exposure; it resulted in growth retardation, muscle weakness, skeletal deformities, hypocalcemia, tetany, and seizures. The encouragement to partake in sensible sun exposure and the fortification of milk with vitamin D resulted in almost complete eradication of the disease in the 20th century.

Epidemiology

There appears to be a resurrection of vitamin D insufficiency with its related symptoms and diseases.[80] In the sunniest areas of the world, rickets is a major health problem because of the practice of purdah or wearing a burka, avoidance of exposure of any skin to sunlight, tall buildings blocking the sun, heavy pollution, and the fact that few foods are vitamin D fortified. Up to 80% of children in Saudi Arabia, India, Turkey, New Zealand, Israel, Egypt, Hong Kong, China, Libya, Lebanon, Spain, Australia, San Diego, and the southeastern United States are vitamin D

deficient.[81] Vitamin D levels are lower seasonally in winter, and in those with darker skin pigmentation, lower dairy intake, higher body mass index,[82,83] and who don't participate in outdoor physical activity. In mid-western adolescents, vitamin D levels were 24% lower during winter compared with summer.[84] In the elderly, the risk of deficiency increases due to the above factors plus decreased renal hydroxylation of vitamin D and decline in the synthesis of vitamin D in the skin.[85]

Human breast milk tends to be low in vitamin D and is influenced by maternal dietary intake and sun exposure. Many pregnant and lactating women are vitamin D deficient, including those taking prenatal vitamins. Supplementation with vitamin D significantly elevated breast milk vitamin D and reduced the incidence of deficiency in breast-fed infants.[86] In one study, fully lactating women received 400 or 6400 International Units (IUs) of vitamin D_3. The higher dose safely and significantly increased maternal and infant circulating serum 25-hydroxyvitamin D (25(OH)D) from baseline compared to controls. The milk from mothers receiving 400 IU decreased in vitamin D activity to a low of 46 IU/L of milk. The milk of the high dose group increased to 873 IU/L of milk. At 400 IU/day vitamin D_3, maternal serum and breast milk vitamin D were not sustained. Infant vitamin D levels were similar when the infant received oral vitamin D or was breast fed from a mother receiving a 6400 IU oral supplement.[87]

Labs

If an infant is not exposed to sunlight or does not receive adequate vitamin D from breast milk or supplemented formula, the infant will inevitably develop rickets.[88] Serum 25-hydroxyvitamin D is used to determine vitamin D status, the risk for both bone-deforming and non-bone-deforming rickets, and the appropriate therapeutic supplement dose. Incidence varies with the lab values used to define the deficiency. Severe, chronic vitamin D deficiency (<15 µg/mL) leads to overt skeletal abnormalities (rickets) in children. The range of 10–20 µg/mL is often used to define subclinical or vitamin D insufficiency. In children, the serum calcium level may be normal, but there is elevated serum parathyroid hormone, 1,25 dihydroxyvitamin D (1,25(OH)2D), and alkaline phosphatase levels.[89] With a new understanding of the many roles of vitamin D and an apparent epidemic of deficiency, the lab value ranges have been changed. Most labs use 25(OH)D concentrations of <32 µg/mL as the definition for vitamin D insufficiency in adults.[83]

The incidence of nutritional rickets appears to be increasing in North American infants and toddlers. National data on hypovitaminosis D among children are not yet available because there is no requirement for screening or reporting cases. Reports from 2000 and 2001 of rickets among some U.S. children confirmed the presence of vitamin D deficiency. The CDC identified 166 cases of nutritional rickets among U.S. children under 18 years of age in studies published between 1986 and 2003.[90] The mean age of presentation of rickets in 43 children from Connecticut was 20 months, and 86% were of African American, Hispanic, or Middle Eastern descent. More than 93% had been breastfed and 15% received vitamin D supplementation. After weaning, the main beverages were soda and juices rather than calcium- and vitamin D–rich dairy.[91]

A larger number of infants, children, and adolescents are vitamin D insufficient (<20 µg/mL). In 40 "healthy" non-White mother–infant pairs, 73% of mothers and 80% infants had 25(OH)D levels <20 µg/mL, despite the fact that 80% of the mothers took a daily multivitamin that contained 400 IU of vitamin D. Forty-eight percent of White girls ages 9 to 11 years in Maine had levels <20 µg/mL at the end of the winter and 17% remained vitamin D deficient at the end of the summer, due either to avoiding sun exposure or to always wearing sun protection. Forty-two percent of adolescent African American and Hispanic children had levels <20 µg/mL in Boston. The CDC found that 48% of African American women ages 15 to 49 years in the United States had levels <15 µg/mL at the end of the winter.[89] Twenty-four to forty-two percent of urban adolescents were vitamin D insufficient (<15 to 20 µg/mL), with 5% severely deficient (<8 µg/mL).[84] Vitamin D insufficiency was found in 49% of 6- to 10-year-old preadolescent African American children in Pennsylvania.[92] Canada and Europe have a similar incidence.

Vitamin D insufficiency also is common in the elderly.[93] Seventy-four percent of ambulatory elderly ages 66 to 89 years living in Colorado were insufficient. Most were White females. Dietary intake was similar, but those taking over-the-counter vitamin D supplements were more likely to have adequate amounts.[83] Of 637 adults in southern Arizona, only 22% had 25(OH)D concentrations >30 µg/mL. Twenty-five percent had concentrations <20 µg/mL, with African Americans (56%) and Hispanics (38%) at greatest risk.[94]

Vitamin D-Related Disorders

Vitamin D receptors have been found on many tissue types, and an insufficiency can influence the development

of many conditions. Muscle function, cellular growth and maturation, immunity, insulin secretion, regulation of calcium and phosphorus, and bone metabolism are all affected or controlled by vitamin D.[95] Vitamin D deficiency during pregnancy may predispose the child to future diseases, such as asthma,[96] non-Hodgkin lymphoma,[97] schizophrenia,[98] hip fracture and bone loss with aging,[89,99,100] and type II diabetes and insulin resistance.[101] Vitamin D therapy may decrease the incidence, morbidity, and mortality from certain diseases, such as malignant melanoma,[102] multiple sclerosis,[103] type I diabetes,[104] Crohn's disease and other autoimmune disorders,[101,105] and cancers of the colon,[106,107] breast,[108] pancreas,[109] and prostate.[110,111]

In adults the risk for osteoporosis and osteomalacia increases with lower serum vitamin D and calcium levels. Osteoporosis is a major public health issue because of the high incidence of fractures, reduced mobility and activities of daily living, decreased quality of life, increased accidents and hospitalization, and increased morbidity and mortality. In 2000, 10% of adults in the United States age 50 years or older had osteoporosis. In 2002, direct care expenditures for osteoporotic fractures alone were estimated to be $12–$18 billion annually.[85,112] Those with lower intakes of vitamin D and lower serum levels appear to be more likely to have lower bone mineral density and a greater incidence of falls. Increased intake of vitamin D from food, supplements, and injections, and increased exposure to ultraviolet (UV) light will increase serum levels.[99] Dietary analysis of vitamin D intake is an unreliable method of predicting serum status. A combination of vitamin D_3 (700–800 IU daily) with calcium (500–1200 mg) was consistent with reduced incidence of fractures and falls.[99]

Public Health Intervention Recommendations to Prevent Vitamin D-Related Disorders

The current recommended amount of dietary vitamin D ranges from 200 to 600 IU, depending on age. Dietary intake in the United States appears to fall below this level in many individuals.[113] The tolerable upper limits for vitamin D supplementation is set at 1000–2000 IU. Vitamin D can cause side effects at excess levels (around 40,000 IU). Because of the growing prevalence of vitamin D insufficiency/deficiency in the U.S. population, the National Institutes of Health Office of Dietary Supplements held a conference in late 2007 on "Vitamin D and Health in the 21st Century—An Update."[114] The goals based on current data and research include:

- Screening newborn infants and those at high risk for vitamin D deficiency
- Educating the public on the importance of vitamin D–containing foods and supplements
- Educating the public on the importance of limited, controlled sun exposure
- Increasing the RDA for vitamin D (being considered at the time of writing by the Office of Dietary Supplements)[114]
- Immediate treatment intervention with high levels of oral and injectible vitamin D in the deficient and insufficient group when identified
- Fortifying additional beverages with vitamin D[89,115]

FLUORIDATION: RISKS AND BENEFITS

Tooth decay remains one of the most common diseases of childhood. Dental caries incidence continues to increase in the 2- to 5-year-old age range despite public health fluoridation intervention.[116] Fewer than 20% of Medicaid-covered children receive one preventive dental service a year. Many states provide only emergency dental services to Medicaid-eligible adults. Poor children have nearly 12 times more restricted-activity days because of dental-related illness than children from higher-income families. Pain and suffering due to untreated tooth decay can lead to problems in eating, speaking, and attending to learning.[117]

The U.S. Surgeon General's 2000 report, "Oral Health in America," emphasizes oral health's link to general health and well-being. The report states that it is important for all health care professionals to assess patients' risks for developing oral diseases, educate patients about health-promoting behaviors, and ensure appropriate referrals to practitioners in all areas of health care.[118,119]

Baby teeth can decay soon after they first appear. Most decay occurs in the upper front teeth when the child is consistently put to bed with a bottle, but any tooth can be affected. The decay may affect the underlying bone structure and prevent development of the permanent teeth. More than half of children ages 5 to 9 years have had at least one cavity or filling, and tooth decay affects 78% of 17-year-olds.[119] Dental caries and poor mouth hygiene are a leading cause of tooth loss in adults.

Bacteria in the mouth digest food particles on and between the teeth. The bacteria use sugars to produce acid that attacks the enamel of teeth, softening and eroding

them. Acids in foods also cause gradual wear of the enamel surfaces. Enamel breakdown leads to cavities. Left untreated the cavity can cause pain and destroy the dentin, pulp, and nerve of the tooth, and lead to tooth loss. Dental erosion and tooth loss are irreversible.

The approach to eliminating dental caries has been to fluoridate water and other products. The CDC has named fluoridation of water as one of the 10 most important public health measures of the 20th century. The American Dietetic Association strongly endorses the appropriate use of systemic and topical fluorides, including water fluoridation, at appropriate levels as an important public health measure throughout the life span.[120] The CDC actively works for water fluoridation, and fluoride treatments and sealants. As of 2002, about 66% of communities in the United States had fluoridated water. In 2000, over one third of the U.S. population was still without this public health measure.[120]

Fluoride is a trace mineral that combats tooth decay by strengthening tooth enamel so it can better resist the acid formed by plaque. Fluoride cannot repair cavities, but it can remineralize and reverse low levels of tooth decay and thus prevent new cavities from forming. Fluoride must be applied to the teeth to have a protective effect. Ingested fluoride has minimal impact on dental caries and can be toxic. At chronic low levels of ingestion, fluoride can cause permanent brown tooth mottling, called *fluorosis*, and skeletal fluorosis, and may increase the incidence of osteoporosis.[121,122]

Fluoridation of public water is viewed as an infringement of personal liberty by some. People have no choice in the water they use unless they buy expensive bottled water. Clear communication from scientists and responsible journalism is important in educating the public about fluoride's safety, benefits, and risks.[123] Acute fluoride toxicity occurs when large amounts of fluoride (usually 3 mg or more) are ingested during a short period of time. Poisoning has occurred at doses of 0.1 to 0.8 mg fluoride (F)/kg of body weight. Symptoms may include nausea, diarrhea, vomiting, abdominal pain, increased salivation, or increased thirst. Symptoms begin 30 minutes after ingestion and can last up to 24 hours. Children under age 6 account for more than 80% of suspected overingestion. Although outcomes are generally not serious, several hundred children require emergency room care each year for excess exposure. At higher levels, acute fluoride ingestion can cause immediate cardiac arrhythmias, seizures, coma, and death.[124]

There is a push by some to add fluoride to soft drinks, bottled water, and milk. Fluoride gets into our water system, so seafood can be contaminated and contain high levels. Increasing exposure to swallowed fluoride increases the risk for adverse outcomes and poisoning. The exact dose needed to cause acute and chronic poisoning is not known. Dietary fluoride estimates use community and individual water fluoride levels and average fluoride levels of beverages and foods prepared with water. There is substantial variation in fluoride intake, however, with some individuals greatly exceeding average intake.[125,126]

Cumulatively, exposure to fluoride from all sources during childhood increases the risk of fluorosis. In children followed from birth to age 3 years, an average daily intake of 0.04 mg F/kg body weight caused fluorosis in 7–12% of children. At 0.04–0.06 mg F/kg body weight there was significantly elevated risk, with 14–23% of children having affected teeth. Above 0.06 mg F/kg body weight, 32–38% had discolored teeth by age 3 years.[127] After age 6 years, the chance of ingesting amounts that would cause dental fluorosis declines. Once a permanent tooth has erupted, it will not show signs of fluoride toxicity.[126]

By age 9 years, 41% of children in the Iowa Fluoride Study had at least one tooth with mild or greater fluorosis and 30% had questionable fluorosis.[128] In 8- to 13-year-olds who had ingested fluoridated water and toothpaste, fluorosis prevalence was found to be 11% and caries prevalence was 32%. Using 1000 ppm-F toothpaste (compared with 400 to 550 ppm-F toothpaste) and eating/licking toothpaste were associated with higher risk of fluorosis without additional benefit in caries protection.[129]

Fluoridated water increases fluorosis and decreases caries. There needs to be a balance to minimize toxicity and prevent cavities. The 1986–1987 National Survey of U.S. School-Children examined over 18,500 children. The sharpest declines in cavities, missing teeth, and dental erosion were associated with water fluoride levels less than 0.7 ppm, with little additional decline between 0.7 and 1.2 ppm. At the lowest levels, 22% of children had fluorosis. At 0.7–1.2 ppm, 30% had fluorosis; 41% of children developed fluorosis at greater than 1.2 ppm. A suitable trade-off between caries and fluorosis appears to occur around 0.7 ppm.[130]

The amount of fluoride in toothpaste varies with brand. Most are about 1000 to 1500 ppm, or about 0.2% to 0.3%. Some children's toothpastes are too low to protect enamel from decay. Fluoride added to public tap and bottled water varies from about 0.8 to 1.3 ppm. Fluoride exposure also occurs from minerals in well water, dental fluoride treatments, beverages and ice made with fluoridated water, air and water pollution, supplements, some

wine, seafood, and chewing tobacco. More than half of 532 ready-to-drink and frozen-concentrate juices and juice-flavored drinks had more fluoride than is recommended, with up to 2.8 ppm.[131,132] Most fluoride mouthwash contains 200–5000 ppm fluoride, and 15–30% is absorbed into the blood after a mouth rinsing.[124]

Tea often contains high levels of fluoride. Infusions of commercially available teas and instant and ready-to-drink tea beverages varied in amount from 0.95 to 6.01 mg/L, with black tea bags containing the highest amount. A longer brewing time increased the fluoride content. Consuming five cups of black tea per day supplied up to 303% of the Safe and Adequate Daily Intake.[133,134] According to the WHO, the maximum fluoride exposure is 2 mg daily for children and 4 mg for adults. If a child drank 800 ml tea a day, 56% of the black tea bags would be unsafe. At 1500 ml of tea consumption, 44% of black teas would be unsafe for adults. At average rates of consumption, 24% of the black tea bags could result in an increasing risk of skeletal fluorosis and fractures. Several cases of osteosclerosis were reported due to chronic fluoride exposure from excessive tea intake. Patients presented with elevated spine bone mineral density; gastrointestinal symptoms such as nausea, vomiting, and weight loss; lower extremity pain sometimes associated with stress fractures; renal insufficiency; and elevated alkaline phosphatase and serum fluoride. Fluoride excess should be considered in all patients with a history of excessive tea consumption. In areas with drinking water fluoridation or other fluoride supplements, excessive fluoride exposure also can readily occur.[134,135]

There currently is no RDA (RDI) for fluoride in the United States. The Academy of General Dentistry recommends 0.3 to 0.7 mg supplemental fluoride daily. The Canadian Dietary Reference Intake (DRI) is 0.1 to 0.5 mg daily for the first 6 months of life, and increases gradually to 1.5 to 3.0 mg for those ages 11 to 18 years. However, 3 mg can cause severe toxicity. Estimated total daily water fluoride intake during the first 6 months of life was as high as 1.73 mg fluoride from tap water and water added to infant formulas, with means from 0.29 to 0.38 mg. These infants often received additional fluoride treatments from their dentists.[136,137] Although 75% of dentists believed they should know the fluoride content of drinking water before prescribing fluoride treatments for children, only 7% routinely tested for fluoride in their local water source. Thus, the risk for excess fluoridation and toxicity exists.[138]

Because of great risk for toxicity, the World Health Organization recommends that fluoride mouth rinsing be restricted to persons at moderate to high risk for dental caries. Fluoride mouth rinsing should not be performed extensively and indiscriminately for public health purposes. Children under 6 years of age are prohibited from fluoride mouth rinsing. It is recommended that young children use only a pea-sized amount of paste and parents should supervise young children as they brush their teeth to minimize swallowing.[139] In the United States, fluoride toothpaste must carry a warning label stating this information because of the rapid and severe toxicity from excessive ingestion.

Public Health Recommendations for Decreasing Dental Caries and Fluoride Toxicity

It is important to determine the total dietary intake of fluoride. The correct amount can prevent cavities. Too much causes damage to tooth enamel, tooth decay, skeletal abnormalities, and renal disease. The Academy of General Dentistry has made the following recommendations:

- Closely monitor the fluoride content of foods and beverages, including infant formulas and water used in their reconstitution, in an effort to limit excessive fluoride intake.
- Establish reliable fluoride surveillance in food and beverage commodities and conduct additional epidemiologic research on fluoride hazards.
- Governmental and international agencies must adopt safe standards of fluoride content in beverages, especially tea.[133–135]
- Control the ingestion of fluoride from dentifrice by young children and emphasize the use of only small quantities.
- Target dietary fluoride supplement regimens only for those children at higher risk for dental caries and who have low levels of ingested fluoride from other sources.[140]
- Manufacturers should label products with their fluoride content.
- Analyze for all sources of fluoride in the diet.[141]

Non-Fluoride Alternatives to Improved Dental Health

Diet and nutrition play a leading role in the formation of cavities. Foods that increase the incidence of dental cavities (caries) are sugary,[142] sticky, and/or acidic.[143] These provide food for bacteria, adhere to the tooth, and erode

the dental enamel. Dental erosion occurs even if using fluoride when consuming foods high in dietary acids and sugars. Soft drinks are the number one dietary risk factor for dental caries because they meet the above criteria.[142,144,145] Consumption of regular and sugar-free soda pop and powdered beverages (like Kool-Aid) also increase caries risk. One-hundred percent juice was associated to a lesser extent.[146–148]

Soda and fruit juices are the top beverages consumed by children, supplying 10–19% of their total daily calories. Soda contributed approximately 67% of all sugar-sweetened beverage calories among adolescents, whereas fruit drinks provided more than half of the sugar-sweetened beverage calories consumed by preschool-age children.[149] When sugar consumption is decreased to about 6–10% of energy intake (15–20 kg per year), dental caries incidence is low. The World Health Organization recommends national goals for lowering daily sugar intake to below 10% of total calories.[145]

Recommendations to decrease dental caries include avoiding all soft drinks and foods high in sugar.[150] Limit fruit juices and other acidic beverages. Brush and floss after each meal and at least twice a day. Chew xylitol gum for 5 minutes when brushing is not possible and to help improve dry mouth.[151] Drink plenty of water. Eating whole fruits and vegetables as healthy snacks is associated with low levels of dental caries.[142] These recommendations would reduce the need for fluoride, decrease fluoride toxicity, and provide a healthier diet.

DIETARY SUGARS AND SWEETENERS

There are three categories of dietary sugars and sweeteners:

- Natural, nutritive, or caloric sugars including sucrose, fructose, glucose, lactose, and galactose. The word *sugar* on food labels designates these natural products.
- Natural *sugar alcohols* or polyols derived from plants and added to "sugar-free" products; these include mannitol, sorbitol, xylitol, lactitol, isomalt, maltitol, and hydrogenated starch hydrolysates. They are added to many processed foods because they provide a sweet taste, add texture, retain moisture, and prevent foods from browning when heated.[152] They are used in foods for diabetics because they provide fewer calories than sugars, convert to glucose more slowly, require little or no insulin to be metabolized, and raise blood sugar more slowly.
- Artificial, non-nutritive, *calorie-free sweeteners* include aspartame, sucralose, saccharine, cyclamates, neotame, and acesulfame-K. These do not raise blood sugar and require no insulin.

Sugar intake has increased worldwide due to urbanization and increased income. Data from 103 countries collected from 1962 to 2000 and three national surveys from the United States collected between 1977 and 1998 all showed an increased consumption.[153] The United States is the largest consumer of sweeteners and is one of the largest global sugar importers, according to the USDA Economic Research Service.[154] Intakes of added sweeteners exceed current dietary recommendations. The USDA recommends no more than 40 grams (about 10 teaspoons) of added sugars per day when consuming 2000 calories.[155] Added sugars are defined as sugars that are eaten separately at the table or used as ingredients in processed or prepared foods.

Between 1950 and 2000, the ingestion of caloric sweeteners—mainly sucrose from beets, cane sugar, and high fructose corn syrup—increased 39%, putting the annual average intake at 152 pounds per person. That is equivalent to 52 teaspoons of added sugar per person per day. After adjusting for losses, the per capita estimate is 32 teaspoons per day in 2000.[155,156] The 2006 per capita consumption of high fructose corn syrup was about 42 pounds per year after loss adjustments.[157] Per capita, cane and beet sugar consumption in 2006 was 45 pounds per year.[157]

The USDA Center for Food Safety and Applied Nutrition noted that Americans age 2 years or older consumed the equivalent of 82 grams (20 teaspoons) of added sweeteners per day, which accounted for 16% of total energy intake. Adolescents consumed the most, averaging 20% of their total energy from added sweeteners.[158] As noted previously, the World Health Organization recommends national goals for lowering sugar intake to below 10%.[145] The 2000 Dietary Guidelines for Americans recommend limited intake of added sugars. Natural, nutritive sweeteners (e.g., sucrose and fructose) are generally regarded as safe additives by the FDA, yet high amounts may not be optimal for health.[159,160] Both types of caloric sugars are common in foods and our diets. Sugar is found in hot dogs, prepared cereals, syrups, fruit drinks, milk products, lunch meats, peanut butter, desserts, soups, crackers, sauces and gravies, salad dressings, flavoring agents, ketchup and other condiments, and many other prepared foods. Sugar is the number one food additive in the U.S. diet.[155]

Beverage intake seems to be a major contributor to caloric intake. Eighty percent of the increase in U.S. sugar intake between 1977 and 1998 was from beverages. This accounted for an additional 83 kcal/day per person or a 22% increase in energy from sweeteners. Milk consumption decreased during this time.[153,161] In 2000, carbonated sodas provided 22–33% of the refined and added sugars in the diet.[155]

Sugars have been associated with various health problems, including dental caries, dyslipidemias, sugar metabolism disorders, obesity, bone loss and fractures, poor diet quality, and poor nutrient density.[162] Those drinking sugar-sweetened beverages and eating candies and sweets were less likely to meet the recommended intake for calcium, folic acid, and iron.[163] Even naturally occurring sugars in 100% fruit juice and fruit punch, but not those in whole fruit, have been associated with increased incidence of type II diabetes.[164]

Sugars and Dentition

The form of sugars and sweeteners can influence dental health through plaque development, oral bacterial count, and loss of enamel. Beverages, whether sweetened with sucrose or artificial sweeteners, still contain citric and phosphoric acid, which can erode dental enamel. Twenty minutes after swishing with regular or diet Coke, teens had a decrease in oral pH. Regular Coke with sucrose had a greater acid-producing potential.[165] Human enamel slices immersed in dozens of soft drinks, sports beverages, energy drinks, and commercial lemonades all caused enamel erosion. Sugared versions of the drinks were more erosive than the artificially sweetened ones. Dentists recommend to rinse the mouth with water after ingestion of sweetened beverages.[166,167]

There were fewer caries in children who had no sweetened soda or powdered drinks, and only small amounts of 100% fruit juice or sugar-free beverages. Regular soda pop, sugared beverages, low milk intake, and high 100% juice intake increased the incidence and number of dental caries.[146] Low income children of less educated parents tend to have higher soda intake, and greater incidence in both obesity and dental caries. Caries and obesity coexist in children of low socioeconomic status.[168] Dietary guidelines for children recommend two or more servings of dairy foods daily, limiting intake of 100% juice to 4 to 6 ounces daily, and restricting other sugared beverages to occasional use.[146]

Sugar alcohols are less likely to cause dental caries than sugars, and when added to chewing gums can prevent dental caries.[152,169–172] Oral *Streptococcus mutans* causes plaque and cavity formation. Xylitol, but not other sugar alcohols, was shown to decrease the growth and acid production of *S. mutans* in the mouth.[173] Chewing gum with 1 gram of xylitol significantly reduced *S. mutans* in young adults.[174] Xylitol is taken up by the bacteria and accumulates as a toxic sugar-phosphate in the cells, resulting in growth inhibition.[175] Xylitol continued to decrease the oral strep activity even in the presence of other common dietary sugars, except fructose.[176]

Maternal dental caries and gingivitis during pregnancy have been associated with fetal developmental problems. Chewing xylitol gum for 5 minutes three times a day appears to be a safe way to reduce the incidence of strep-induced caries during pregnancy and the related fetal complications.[177] Mothers with high counts of salivary *S. mutans* were randomly assigned into three experimental chewing gum groups. Children born to mothers who chewed gums with xylitol as the single sweetener during the time of eruption of the first primary teeth had fewer cavities compared with those who used gums containing fluoride, sorbitol, and lower amounts of xylitol.[151] Animal studies have shown that dietary xylitol supplementation diminishes bone resorption and protects against experimentally induced and age-related osteoporosis.[178–180] In excessive amounts, however, sugar alcohols can cause bloating, diarrhea, and adverse weight changes.[181–185]

Several sweetener companies have petitioned the FDA to be allowed to make the claim that their product does not produce dental caries. So far, the artificial sweetener sucralose is the only one to be approved to make that claim.[186–188]

High-Fructose Corn Syrup

High-fructose corn syrup (HFCS) is enzymatically derived from corn syrup (glucose) in order to increase the fructose content. High-fructose corn syrup is commonly used in food manufacturing because it is comparable in sweetness to sucrose, but cheaper. High-fructose corn syrup has replaced sucrose as the main sweetener in beverages in the United States. The average American consumed approximately 28 kg in 2005, versus 27 kg of sucrose.[189] According to the USDA, the consumption of HFCS increased more than 1000% between 1970 and 1990, far exceeding the changes in intake of any other food or food group. HFCS now represents greater than 40% of caloric sweeteners added to foods and beverages. Estimated intake is 132 kcal per day for all

Americans age 2 years or older. The top 20% of consumers of caloric sweeteners ingest 316 kcal from HFCS per day.[190]

The small amounts of fructose that occur naturally in fruits and vegetables are unlikely to have deleterious effects. Problems arise when fructose is taken in high, concentrated doses, such as with high fructose corn syrup. Excess fructose consumption, especially as high fructose corn syrup, may be associated with the development of diabetes, cardiovascular disease, liver disease, gout and uric acid kidney stones, metabolic syndrome, and obesity. Long-term effects have not been adequately studied in humans.

Fructose raises uric acid levels, and uric acid inhibits nitric oxide. Insulin requires nitric oxide to stimulate glucose uptake. Metabolic syndrome and gout correlate with an elevation in serum uric acid levels. Over 14,000 adults from the Third National Health and Nutrition Examination Survey showed serum uric acid levels increased with increasing sugar-sweetened soft drink intake. Rats ingesting high fructose diets developed hyperinsulinemia, hypertriglyceridemia, hyperuricemia, and weight gain. Lowering uric acid with a drug blocking agent prevented or reversed the adverse effects of dietary fructose.[191,192]

The development of nonalcoholic liver disease may be associated with excessive dietary high fructose corn syrup intake. Consumption of fructose in patients with diagnosed nonalcoholic fatty liver disease was nearly two- to three-fold higher than in controls. Fructokinase, an important enzyme for fructose metabolism, and fatty acid synthase, an important enzyme for lipogenesis, were increased in HFCS patients.[193]

Fructose promotes the formation of advanced glycation end products (AGEs), such as hemoglobin A1c, which appear to play a role in the aging process. Advanced glycation end products may be toxic to vascular, renal, and ocular tissue, especially in those with diabetes, and enhance the formation of atherosclerosis.[194,195] Data from the Third National Health and Nutrition Examination Survey (1988 to 1994) found that adults with diabetes reported drinking three times more diet soda than adults without diabetes. Those who had one or more drinks of diet soda per day had a significantly greater HbA1c level compared with those who drank none.[196] Women who drank at least one sugar-sweetened soft drink or fruit punch a day had nearly twice the risk for diabetes over 4 years as women who drank less than one a month.[197]

Epidemiologic and biochemical studies clearly suggest that high dietary intake of fructose is an important factor in the development of metabolic syndrome.[198,199] Fructose consumption induces insulin resistance, impairs glucose tolerance, increases blood insulin and triglycerides, and causes hypertension as the liver and intestines overproduce atherogenic lipoprotein particles.[156,198] In diabetics and obese individuals, high intake of fructose increases the formation of low-density lipoprotein (LDL) cholesterol. Consuming large amounts of fructose can lead to the development of a complete metabolic syndrome in rodents. In humans, fructose consumed in moderate to high quantities in the diet increases plasma triglycerides and alters hepatic glucose homeostasis.[200–202] Rats fed 60% fructose diets developed multiple kidney problems with glomerular hypertension and damage to the vascular tissue.[199] Over 6000 middle-aged women in the Framingham Heart Study were evaluated for development of metabolic syndrome during a 4-year time span. Higher soft drink consumption increased the risk for metabolic syndrome by 44%, being obese by 31%, having an increased waist circumference by 30%, having increased blood pressure by 18%, having increased fasting blood sugar by 25%, having increased triglycerides by 25%, and having lower high-density lipoprotein (HDL) cholesterol by 32%. Soft drink consumption was associated with a higher prevalence and incidence of multiple metabolic risk factors.[203]

The increased use of HFCS in the United States mirrors the rapid increase in obesity. The digestion, absorption, and metabolism of fructose differ from those of glucose. A high influx of fructose into the liver upsets glucose metabolism and glucose uptake, and leads to a significantly enhanced rate of fat and triglyceride synthesis. Fructose may increase the risk for obesity due to its lack of stimulating insulin release. Insulin, leptin, and ghrelin regulate food intake and long-term energy balance through the central nervous system. Glucose increases insulin much more than fructose. Insulin stimulates leptin and suppresses ghrelin. High leptin and low ghrelin tends to suppress appetite. In some studies, the HFCS group had significant decreases of circulating insulin and leptin and increased ghrelin concentrations, which could lead to enhanced hunger and increased caloric intake.[156,190,198,204–206] Based on these findings, there is an urgent need for increased public awareness of the risks associated with high levels of fructose consumption, and greater efforts should be made to curb the supplementation of packaged foods with high fructose additives.[198]

In contrast, in other studies of normal weight men and women who ate isocaloric meals high in either sucrose or HFCS, there were similar changes in plasma glucose, insulin, leptin, and ghrelin. There was no difference

between sucrose and HFCS in perceived sweetness, hunger, satiety, or caloric intake after consumption and at the next meal. Both sucrose and HFCS elevated postprandial triglycerides.[202,205,206] Those ingesting a noncalorie diet soda or no beverage had similar caloric intake. The caloric intake at the next meal increased in all groups and was directly correlated with satiety ratings, ghrelin, insulin, and glucose levels.[207,208] Based on the currently available evidence, an expert panel of the Center for Food, Nutrition, and Agriculture Policy concluded that HFCS does not appear to contribute to overweight and obesity any differently than do other sources of calories.[209]

Sweetened Beverages and Obesity Incidence

There is an epidemic of obesity in U.S. children and adults. Weight gain during childhood significantly increases the risk for early onset obesity-related diseases. The relationship of natural and artificial sweeteners to obesity is unclear. Many studies are too short to show a difference in weight loss or gain. The trend appears to favor weight gain when adding caloric beverages to a regular diet and weight loss when substituting a sugar-free beverage for a caloric beverage. When following a calorie-restricted weight loss diet, there appears to be no difference in weight loss or gain due to the beverage.

Children consume high amounts of soda and sweetened beverages. Sugar-sweetened beverages accounted for 15% of all drinks consumed and 3% of total energy intake in one group of 5 to 7 year olds.[210] From 1973 to 1994, 81–83% of children consumed sugared beverages. There was a corresponding decrease in milk consumption as ingestion of sugar-sweetened beverages increased. Total calorie intake was significantly higher in those who drank the greatest amount of sugared beverages. Body mass index (BMI) significantly increased in children who drank any form of sugared beverage, but the weight gain did not correspond to the amount of beverage or to the total calories consumed.[211]

Almost 2000 preschool children were tracked from 1998 to 2002 in the Longitudinal Study of Child Development. At the end of 2 years, 15% of children who had sugary beverages four or more times per week were overweight compared to 7% of children who had no sugared beverages. Ingesting sugared beverages more than doubled the odds of being overweight and tripled the odds in low income families.[212] Children who consumed one to three sugar-added beverages per day gained an additional 1 to 2 kg/m^2 during the 2-year study of >10,000 children in the U.S. Growing Up Today Study. For a 5-foot-tall child, every 1-cup daily serving would add a 1-pound weight increase each year attributable to the beverage alone.[213] The American Dietetic Association recommends that parents limit the quantity of sweetened beverages because it may increase the risk for weight gain.[212]

The Harvard School of Public Health reviewed over 91,000 women in the Nurses Health Study II and found that having one or more daily sugar-sweetened beverages as soft drinks or fruit punch was associated with a greater amount of weight gain (4–5 kg increase) and an increased risk for development of type II diabetes over 4 years. The diabetes and weight gain were possibly caused by excessive calories and large amounts of rapidly absorbable sugars.[197]

In contrast to these studies, the North Dakota Special Supplemental Nutrition Program for Women, Infants and Children, found no relationship between beverage consumption and weight gain or body mass index among 2- to 5-year-olds during 1 year.[214] The total amount of milk, fruit juice, fruit drink, and soda consumed were associated with an increase in total calorie intake, but not with body size.[215] USDA population dietary survey databases from 1989 to 2002 totaling 38,409 individuals, ages 20–74 years, showed that consumption of sugar-sweetened beverages was not significantly associated with obesity or higher BMI. Obesity was associated with dietary fat content, however.[216] When obese subjects restricted their calories in a weight loss program, there was no difference in weight loss among those who consumed sugared beverages, complex carbohydrates, or artificial sweeteners.[217]

Switching to diet sodas may either contribute to weight gain or be an attempt to lose weight. Replacing caloric beverages with low-calorie or noncaloric beverages, such as water or unsweetened tea and colas, might decrease total energy intake.[218] In one study, those who ate as they wished consumed fewer total calories when sugared beverages were replaced by an artificial sweetener or by complex carbohydrates. In the long term, using a nonsugared beverage might be beneficial for weight maintenance.[217] Increases in diet soda consumption were significantly greater for overweight children and for children who gained weight as compared to normal weight subjects. Diet soda consumption was the only type of beverage associated with an increase in body mass index during one 2-year study.[219] Heavier children may consume low-energy beverages as part of an ineffective weight-control program.[210]

Calories ingested as liquid beverages may not signal satiety, may change hunger signals, and may increase

portion size. The extra liquid calories can contribute to obesity. When subjects were given liquid beverage portions of 12 or 18 fluid ounces at a meal, the larger portions resulted in increased beverage consumption and 10–26% more calories.[218] Overweight subjects who consumed large amounts of sucrose, mostly as beverages, had increased total caloric consumption, body weight, fat mass, and blood pressure after 10 weeks. These effects were not observed in a similar group of subjects who consumed artificial sweeteners.[220] When normal weight women added a sucrose-containing beverage to their diet, they decreased their intake of other foods, but the total caloric intake was still greater than before the addition. There was a trend towards weight gain. There was no change in hunger with either sucrose or artificially sweetened beverages.[221–223]

In other studies, a few people reported decreased hunger after ingesting aspartame, possibly due to the neurotransmitter effect of phenylalanine influencing appetite.[224] In African Americans, the intense artificial sweetener aspartame increased consumption of the foods. Most people habituate to frequently consumed foods and temporarily lose desire for that item; however, African Americans showed no habituation to foods and beverages sweetened with the aspartame-containing NutraSweet. In fact, they had a significantly greater desire for intensely sweetened foods, regardless of calorie content. The greater desire for intense sweet tastes may be a factor in the elevated incidence of obesity and diabetes in African Americans.[225]

Artificial Sweeteners

Five artificial, non-nutritive sweeteners with intense sweetening power have FDA approval (acesulfame-K, aspartame, neotame, saccharin, and sucralose). Cyclamates are not approved in the United States, but are used in Canada and other countries. Artificial sweeteners supply from 0 to 4 kcals per gram, but because they are intensely sweet, less is used per serving size. When there is less than 1 gram per serving, the product can be labeled "calorie-free." The artificial sweeteners are not sugars, so products they are in may be labeled "sugar-free."

The acceptable daily intake of artificial sweeteners (i.e., the level that a person can safely consume every day over a lifetime without risk) is set by the Joint FAO/WHO Expert Committee on Food Additives. Studies of U.S. and world intake demonstrated levels of aspartame, cyclamate, and acesulfame-K were below the acceptable daily intakes.[226, 227] The estimated daily intake of saccharin and aspartame were 41% and 12% of the acceptable daily intake, respectively. The sugar alcohols have no set acceptable daily intake.[228] Intake of the newer artificial sweeteners, sucralose, and neotame, have no consumption data at this time.[227] European studies found the only intense sweetener to possibly exceed its upper limit of intake were cyclamates taken by children, especially if diabetic, at 317% of the acceptable dietary intake.[227,229–231] The American Dietetic Association supports the intake of artificial sweeteners and sugar alcohols.[159,160]

The long-term safety of artificial sweeteners is unknown, especially for pregnant women, infants, and children. Exposure to non-nutritional food additives, especially in combinations, during crucial periods of fetal and child brain development can lead to incorrect myelination of the white matter. Exposure to these artificial chemicals could increase the risk for abnormal learning disorders, attention deficit disorder and hyperactivity syndrome, autism, dyslexia, bipolar disorders, and tone deafness.[232]

NutraSweet or aspartame is composed of phenylalanine, aspartic acid, and methanol. These play an important role in neurotransmitter regulation and can be metabolized to a number of highly toxic derivatives. Both in human cell lines and in rat studies, cells incubated with or exposed to aspartame metabolites showed significant neurological enzyme activity impairment. The impaired activity correlated with the concentration of metabolites and occurred at levels commonly ingested. Neurological symptoms, including headaches, insomnia, seizures, impaired learning and memory processes, and mental disorders may be related to changes in regional brain concentrations of catecholamines or to high or toxic concentrations of aspartame metabolites through impairment of membrane enzyme activity.[233–235] Aspartame plus a common yellow food dye, tartrazine, significantly inhibited healthy neural growth and prevented brain cancer cell death in mice. The neurological damage was found at concentrations of additives theoretically achievable by eating a typical snack and sweetened beverage.[236] A case of epileptic seizures after a massive intake of Diet Coke appeared to be caused by the combination of high doses of caffeine plus aspartame.[237]

Aspartame is consumed by hundreds of millions of people worldwide. It is used in over 6000 products, including soft drinks, chewing gum, candy, desserts, and yogurt, as well as in more than 500 pharmaceutical products, in particular, syrups and antibiotics for children.[238] According to the NutraSweet Company, there is no association between aspartame and headaches;

seizures; changes in behavior, cognition, and mood; or allergic-type reactions, and that it is safe when used as intended.[239] Short-term use rarely causes problems. In a randomized, double-blinded, placebo-controlled, crossover study, 48 young, healthy adults consumed 15 or 45 mg/kg body weight of aspartame as soda or capsules for 20 days. At these doses, there were no effects on neuropsychologic, neurophysiologic, or behavioral functioning during the 20 days of the study.[240]

Fetal and newborn exposure to low potency carcinogens produces an overall increase in the carcinogenic effects over a lifetime. When a pregnant animal is exposed to some artificial sweeteners, there is a greater incidence in cancerous tumors in her offspring. Malignant brain tumors were found among animals treated with aspartame whereas no tumors developed in the control group.[238] In this study, aspartame was added to the standard diet of rats. There was a significant, dose-related increase of lymphomas/leukemias and malignant tumors of the breast, renal pelvis, and ureter in females and malignant tumors of peripheral nerves in males. Therefore, aspartame appears to be a carcinogenic agent, capable of inducing malignancies at various dose levels, including those lower than the current acceptable daily intake for humans (50 mg/kg of body weight in the United States, 40 mg/kg of body weight in the European Union). The earlier the animal was exposed, the greater and earlier the incidence of cancers. Lifetime exposure begun during fetal life predicted the incidence of the cancer.[238,241–244]

In spite of animal studies showing carcinogenesis of aspartame, the European Food Safety Authority felt that the product was safe because most people do not reach the acceptable daily limit and the use of a noncalorie sweetener might reduce the incidence of calorie-related diseases, such as diabetes and cardiovascular disease.[245] Also, there are no studies that confirm a relationship to human cancers. Some case-control studies, however, showed a 30% elevated cancer risk for heavy artificial sweetener use.[246] Other case-control studies published between 1991 and 2004 indicate a lack of association between saccharin, aspartame, and other sweeteners and the risk of several common cancers.[247] In a National Cancer Institute prospective study on over 470,000 adults in the National Institutes of Health/AARP Diet and Health Study, higher levels of aspartame were not associated with an increase in hematopoietic or brain cancer risk over a 5-year span.[248] It is too early to have any epidemiologic evidence about carcinogenic risks for the newer sweeteners. Also, because many artificial sweeteners are combined in products, the carcinogenic risk is difficult to assess.[246]

Sucralose has been reported to trigger migraine headaches in some individuals.[249] A study conducted by McNeil Specialty Products, the company that makes sucralose (Splenda), found no organ or skeletal development abnormalities in pregnant rats or rabbits, and their fetuses after ingesting high doses of their sweetener. The few maternal and fetal deaths were thought to be due to significant diarrhea caused by poorly absorbed compounds in the product.[250]

FAST FOOD

Fast food, a word coined in 1954, is defined as relating to or specializing in food that can be prepared and served quickly.[251,252] It now is used as a general term for a limited menu of foods that lend themselves to production-line techniques; suppliers tend to specialize in products such as hamburgers, pizzas, french fries, fried chicken, or sandwiches with little regard for quality. The foods tend to be fried or grilled and high in saturated and trans fats, sodium, sugar, and calories, and low in fiber, fruits, vegetables, phytochemicals, vitamins, and minerals. Junk food is often used as a synonym, but is most commonly used to indicate any food of low nutritious value and lots of calories.[252] There is no defined list of junk foods, but they usually include foods with content high in sugar (soft drinks), salt (chips), alcohol, and saturated (fried meats) and trans fats (donuts and pastries). Fast food can be healthy, but most often it is junk. Fast food also may contain contaminants of unknown long-term safety.

Fast Food's Relationship to Disease

Eating a diet high in unbalanced, nutrient-poor fast food and junk food tends to promote obesity, dental caries, diabetes, and cardiovascular, kidney, and other diseases. We don't know exactly why fast food is related to these diseases, but it is most likely due to the excess fats, sugars, sodium, cholesterol, and contaminants, and their metabolic toxins. Fast food often contains contaminants and filth because of the way the food was grown, handled, packaged, killed, prepared, or processed. Contaminants in fast food may include antibiotics, added hormones, *E. coli*, heterocyclic amines, rancid and trans fats, nitrosamines, glycated proteins, salmonella, animal feces, fillers, dyes, preservatives, and animal viruses and prions. Added estrogenic hormones in fast food beef and milk may be related to increased male infertility.[253] Most beef served in the United States has added synthetic hormones. Women

who eat large amounts of beef during their pregnancy appear to bear sons who have a lower sperm count and a higher rate of infertility as adults. The environmental estrogens in beef may alter a man's testicular development in utero and adversely affect his reproductive capacity.[254]

Advanced glycation end products form in processed foods, especially when they are heated, irradiated, and ionized. Chronic diseases and inflammation are associated with consumption of glycation end products and advanced oxidized fat products. These products attach to and stimulate cell surface molecules. Continuous intake leads to excessive tissue stores, modification of gene activity, increased inflammation, damage to cell structures, and altered cell function.[255–257] Spongiform encephalopathy and scrapie may be related to the consumption of glycated proteins contained in animal feed.[258] Sodium nitrite, which is added as a coloring agent and preservative to processed meats like hot dogs, bacon, and lunch meats, could be directly toxic to pancreatic beta cells. In a study of 42,000 men, those who ate processed meats five times per week had a 46% higher risk of diabetes than those who ate the meats less than twice a month.[259]

One key dietary trend that promotes obesity and unhealthy eating is the shift towards away-from-home consumption of foods. The need for large and quick quantities of cheap food promotes buying packaged snacks and eating at fast food outlets. Average food spending per person increased about 2.4% from 1992 to 2002, and spending on food eaten away from home increased about 43%.[260] Away-from-home meals and snacks captured 47% of the U.S. food dollar in 2001, up from 45% in 1991 and 40% in 1981.[155] Childhood consumption of fast foods increased fivefold between the late 1970s and mid-1990s. During that time, the number of fast food restaurants more than doubled, to an estimated 250,000 nationwide.[261] From 1982 to 2002, there were large increases across all age groups in total energy from salty snacks, soft drinks, and pizza, and large decreases in energy from low- and medium-fat milk and medium- and high-fat beef and pork.[262]

Average annual consumption of fatty cheeses increased 287% between the 1950s and 2000, from 8 pounds per person to 30 pounds. More than half comes in commercially manufactured and prepared foods, such as pizza, tacos, nachos, salad bars, fast-food sandwiches, bagel spreads, sauces for baked potatoes and other vegetables, and packaged snack foods. Between the 1970s and 1997, fat consumption jumped 12 percentage points, probably due to the higher consumption of fried foods in food service outlets, the increase in consumption of high-fat snack foods, and the increased use of salad dressings. French fry intake, eaten mainly in fast-food eateries, increased 63% during the same period. We also eat too much refined grain including fast-food sales of buns, donuts, dough products, and tortillas.

Due to few fruits, vegetables, and whole grains in fast food, there are limited amounts of vitamins, some minerals, fiber, antioxidants, phytonutrients, omega-3 fats, and other unknown but potentially beneficial nutrients. Inadequate consumption of fruits and vegetables has been associated with obesity-related problems such as cardiovascular disease and diabetes. Fruits and nonstarchy vegetables may protect against excessive weight gain because of their low energy density and high fiber content.[263]

Food choice is strongly influenced by economics. When subjects in one study attempted to follow a healthy diet based on the Healthy Eating Index, the average daily cost for food increased about $1.75.[264] For a family of four, that adds $210 a month to the food bill, which many families find difficult to afford. Changing fast food and fruit and vegetable prices may affect people's dietary quality and to some extent their adiposity. Based on the USDA Continuing Survey of Food Intakes by Individuals, when fast food prices increase and fresh vegetable prices decrease, people tended to eat more fiber and less saturated fat, cholesterol, and sodium, and have better overall diet quality.[263]

Food choices are strongly influenced by advertising on television. Junk food advertising is highly prevalent on children's TV, while healthy eating is rarely promoted. Children are more likely to eat junk food and have positive attitudes towards junk food with greater TV and advertisement viewing. Ads for nutritious foods promoted positive attitudes and beliefs concerning these foods. Promoting nutritious foods on TV and limiting junk food advertising would help to normalize and reinforce healthy eating.[265] Despite the recent trend of fast food outlets advertising healthy meals, they are not all healthy choices and the nutrient density varies significantly from one site to another. Analyses of french fry and chicken nugget samples bought in McDonalds and Kentucky Fried Chicken (KFC) outlets in 35 countries in 2005–2006 showed that the total fat content of the same menu varies from 41 to 65 g at McDonalds and from 42 to 74 g at KFC. Fast food from major chains in most countries still contains unacceptably high levels of industrially produced trans-fatty acids. Trans fats have powerful biological effects and may contribute to increased weight gain, abdominal obesity, type II

diabetes, and coronary artery disease. Trans fats have been lowered or removed from many fast food chains in the U.S., but the food quality and portion size need to be improved before it is safe to eat frequently at most fast-food chains.[266]

Fast Food's Relationship to Obesity and Diabetes

Obesity and insulin resistance epidemics are related to a dramatic rise in consumption of fast food over the past 30 years. The characteristics of fast food, including high energy density, high fat, high fructose and sucrose, low fiber, and low dairy intake, favor the development of insulin resistance, obesity, and higher body mass index.[267] Those eating junk food regularly have multiple vitamin and mineral deficiencies.[268] Eating junk food during pregnancy and lactation may be an important contributing factor in the development of obesity. Rat offspring born to mothers fed a junk food diet during pregnancy and lactation had increased body weight and body mass index and developed an exacerbated preference for fatty, sugary, and salty foods at the expense of protein-rich foods when compared with offspring fed a balanced diet.[269] There appear to be nutritional factors inherent to fast food, such as low levels of dietary fiber, high palatability, high energy density, high fat content, high glycemic load, and high content of sugar in liquid form that promote excess caloric intake through gorging.[270]

Children and adults consume large amounts of junk and fast food. Junk food supplied 24% of the calories in a study on healthy 4-year-old children. Eighteen percent were overweight or obese and 67% had a sucrose intake exceeding nutrition recommendations.[268] Thirty percent of children and adolescents consume fast food on a typical day.[271] Of over 17,000 adults and children who participated in the Continuing Survey of Food Intakes by Individuals, fast-food use was reported by 37% of the adults and 42% of the children.[272] Seventy-six percent of adult African Americans reported eating at fast-food restaurants during the previous 3 months, with 22% eating fast food "often."[273] Increased consumption of meals prepared outside the home at restaurants and fast food outlets and increased sweetened beverage consumption are related to obesity.

Fast food provided more than one third of the day's calories, and total and saturated fat.[274] Those who ate fast food consumed more total calories, more calories per gram of food, more total and saturated fat, more fried foods, more sodium, more total carbohydrates, more added sugars, more sugar-sweetened beverages, less fiber, less milk, and fewer fruits and nonstarchy vegetables, and had a lower intake of vitamins A and C.[272,273,275] Calorie intake increased and vitamin and mineral intake decreased with increased intake of fast foods. Adults who reported eating fast food had a higher mean body mass index. There was a significant relationship between fast-food consumption and being overweight.[274]

In a study of over 14,000 children ages 9 to 14 at baseline, those who consumed greater quantities of fried fast food ate more calories, had a poorer diet quality, and gained more weight over time.[271,276] Teens who frequently consumed fast-food meals were more likely to work, watch TV, have unhealthy foods at home, and feel it would be difficult to eat healthy meals. They were less concerned with healthy eating and thought their peers and mothers were unconcerned with healthy foods.[277] Adults who ate fast food "often" or "usually" tended to be younger, low income, non-White, never married, obese, physically inactive, and multivitamin non-users. They rated their health as fair to poor, did not believe diet influenced cancer development, did not feel they could change eating behaviors or their weight, showed poor dietary restraint, watched TV more often, ate fewer low fat foods, and thought it would be difficult to prepare healthy meals and order healthy food in restaurants.[273,275] During a 3-year study, those who increased fast-food restaurant meals also increased in body weight, total energy intake, percentage of fat intake, and intake of hamburgers, french fries, and soft drinks; physical activity decreased.[275]

Parents who purchased fast food for meals three or more times per week were more likely to have soda pop and chips in the home. Families that ate fast food less often were significantly more likely to have vegetables and milk served at home. Greater intake of fast foods and snack foods at home were related to higher weight in the parents.[278] A cross-sectional study of over 33,000 adults indicated that regular intake of high amounts of fried food was related to increased risk for both general and central obesity.[279]

Noncommunicable, chronic illness has risen in third-world countries and has been attributed to the influx of cheap, unhealthy fast-food meals and snacks that have replaced home-prepared, balanced meals.[280] Introducing fast-food chains and Westernized dietary habits into third-world countries has increased the incidence of both general and abdominal obesity. Large portion sizes with high calories, high fat, and high trans fat content, and sugar-rich soft drinks are quite different from the

traditional diet in China, for example. Fat intake there increased by 15–20% and explains some of the country's overall weight gain.[281] High intake of trans fat has been related to abdominal obesity. Abdominal obesity is related to the development of heart disease, diabetes, metabolic syndrome, and some endocrine disorders.[281]

Health authorities have called on fast food chains to decrease the sizes of menu items; however, the chains are responding slightly or not at all. Sizes of sodas, french fries, and hamburgers in 2006 were compared to the sizes in 1998 and 2002. McDonald's phased out its largest offerings, making current items similar to 1998 sizes but greatly larger than 1955 sizes. Burger King and Wendy's increased portion sizes. It is unlikely that fast-food companies will voluntarily reduce portion sizes. Thus, governmental policies are needed to reduce energy intake from fast food.[282] In 2001 the USDA regulations emphasized that "food service areas must not provide access to foods of minimal nutritional value during student meal periods" and that "State agencies may impose other restrictions on all foods sold anytime throughout their schools."

Fast Food and Mad Cow Disease

The USDA reports that between 20% and 40% of U.S. dairy herds are infected with bovine tuberculosis. Foodborne bovine tuberculosis may be a vector for Creutzfeldt-Jakob disease (human mad cow disease). There is a link between the consumption of contaminated meat and bovine spongiform encephalopathy, Alzheimer's disease, Creutzfeldt-Jakob disease, and the other spongiform encephalopathies such as mad cow disease. Eating contaminated hamburgers was associated with an outbreak of mad cow disease in 2004. Meat eaters have three times the risk of developing Alzheimer's as opposed to vegetarians. Alzheimer's, Creutzfeldt-Jakob, and mad cow disease might be caused by eating the meat or dairy in consumer products or feed.[283] Dairy cows fed diets high in fast-absorbing carbohydrates developed carbohydrate disorders that were able to produce neurodegenerative disorders. Developing bovine spongiform encephalopathy is very similar to the development of Alzheimer's disease in those with diabetes mellitus.[284]

Cancer and Fast Food Intake of Processed and Prepared Meats

The meat industry has provided scores of new brand-name, low-cost, processed products for consumers and fast food operators. The USDA reports that 74% of Americans consume food away from home. Twenty-seven percent of Americans eat beef and chicken at home and 12 to 15 percent buy them at restaurants and fast food outlets. That amounts to 9 grams of beef and 7 grams of chicken eaten daily outside the home.[285] McDonald's, the fast food industry leader in beef burger sales, claims it sells 75 burgers every second world wide.[286] American meat consumption continues to increase. In 2000, total meat consumption (red meat, poultry, and fish) reached 195 pounds (boneless, trimmed-weight equivalent) per person, which was 57 pounds above the average annual consumption in the 1950s. Each American consumed an average of 7 pounds more red meat and 46 pounds more poultry than in the 1950s. Rising consumer incomes and low meat prices in the 1990s explain much of the increase in meat consumption.[155]

Red meat that is fried, well/very well done, processed, or grilled has been shown to be associated with a higher risk for and recurrence of colorectal,[287,288] pancreatic,[289] prostate,[290–292] brain, and breast cancers. The exact mechanism is unknown, but elevated exposure to gene-toxic heterocyclic amines and polycyclic aromatic hydrocarbons are the most likely causes. These chemicals are formed when meat is cooked at high temperatures for a long period of time. A large colonoscopy-based case-control study found that high consumption of total meat, red meat, or heterocyclic amines and polycyclic aromatic hydrocarbons significantly increased the risk for hyperplastic polyps by 50–60%. High intake of well-done meat and well-done red meats showed an increased trend for the risk of large adenomas.[293] The National Institutes of Health/AARP Diet and Health Study cohort of over 537,000 individuals, ages 50 to 71 years, indicated that total, red, and high-temperature cooked meat intake was positively associated with pancreatic cancer. Heterocyclic amine intake showed a significant 29% increased risk. Men with the highest intakes of grilled/barbequed and broiled meat had a 50% increased risk for pancreatic cancer and a doubling of risk for overall meat-mutagenic activity.[289] Heterocyclic amines induce prostate cancer in rats. Grilled meat consumption, especially red meat and hamburger, was significantly associated with higher carcinogen levels in human prostate epithelial tumor cells. Lower consumption of grilled red meats may reduce prostate cancer risk.[292,294]

Dietary heterocyclic amines were measured in several foods. Pan-fried meats, especially chicken and smoked beef, were the largest source. Nonmeat items

were generally low except for some potato chip products. The U.S. population's average intake of heterocyclic amines is about 9 μg/kg/day. Heterocyclic amine intake was 25% greater in children than in adults. The greatest intake was among African American males, who consumed two- to three-fold more than White males. The higher intake may partly explain why prostate cancer kills approximately twice as many African American men as White men.[295,296] Cancer risk due to dietary exposure to heterocyclic amines is of concern and needs to be reduced either by regulatory efforts or by modifying food manufacturing procedures.[296]

Maternal dietary exposure to N-nitroso compounds from sodium nitrites and other nitrosamine or nitrosamide products during pregnancy is associated with risk of childhood brain tumors. Cured, processed meat is one dietary source. Most epidemiologic studies have found a significant positive association between maternal intake of cured meat during pregnancy and the risk of childhood brain tumor.[297] Frequent hot dog consumption during pregnancy increased childhood brain tumor risk by 33%, and sausage consumption increased the risk by 44%.[298]

TRANS FATS

Trans-fatty acids occur naturally in many beef, lamb, and dairy products, but the main sources are artificially created during partial hydrogenation of plant oils. For the purpose of nutrition labeling, trans-fatty acids are defined as "the sum of all unsaturated fatty acids that contain one or more nonconjugated double bonds in a trans configuration."[299] Saturated fats have no double bonds. Unsaturated fats have one or more double bonds. The naturally occurring form has a bend at the bond and is called a cis configuration. When the double bonds in unsaturated fats are broken and attached to hydrogens, they act as saturated fats. The double bonds that do not break, but instead rotate into a linear structure, are called trans fats. Hydrogenated trans fats are used in many products because they increase the shelf life of the food. Partially hydrogenated fats contain the highest amounts of trans fats because many double bonds are rotated in the process. When an animal or human eats trans-fatty acids, the abnormal fats become part of the cell membrane or organ structure and adversely influence cellular and hormonal functions. When humans ingest milk or meat from animals fed trans fats, those trans fats deposit in our bodies.[300,301]

Adverse Effects of Trans-Fatty Acids

Although much more research is required, the main adverse effects of trans fats appear to be due to increasing inflammation, displacing healthy fats in cells and tissues, altering cellular communication and function, and replacing essential fatty acids.[302] A high intake of industrially processed foods with trans fats increases the risk of invasive breast cancer,[303] and female ovulatory infertility[304] The adverse effects of trans-fatty acids can be of significant health concern to the fetus and newborn and may lead to future risk for adolescent and adult disease. Pregnant women were consuming large amounts of trans fats, from bakery goods and fast food.[305] Trans-fatty acids cross the placental membrane and deposit in the fetus, making growth impairment a possibility.[306]

There is a dose-related increased risk for miscarriage or fetal anoxia during pregnancy when the mother consumes trans-fatty acids.[307,308] DHA is crucial for proper brain development in the fetus and newborn. DHA and other essential fats were lower and trans and saturated fats were higher in brains of offspring exposed to trans fats in utero. Trans fats seem to inhibit the action of enzymes necessary to form essential fatty acids in the developing brain.[300,309] Intrauterine and maternal milk trans-fatty acid content is directly related to the mother's consumption of hydrogenated fats.[300,306,310,311] Mid 2000 data showed that breast milk from U.S. and Canadian women contained about 7% trans fats, which was greater than that of other countries.[312] A 2009 study, found ruminant and human milk had similar levels of TFAs of 1% to 4%.[313] Newborns rapidly accumulate trans fats in organs and adipose tissue, which displaces healthy fats.[314,315]

Ingesting trans fats during pregnancy and lactation may increase the risk for future insulin resistance, obesity, cardiovascular disease, and diabetes in the offspring. Plasma triglycerides and total cholesterol elevate and there is increased expression of genes involved with insulin resistance, decreased levels of hormones related to appetite control, and increased proinflammatory adipokines related to cardiovascular disease in the offspring of female rats fed trans fats during pregnancy.[316] Trans-fat–exposed offspring also had significantly higher blood glucose, fewer insulin receptors, and impaired appetite regulation compared to non-trans-fat–exposed controls. Early exposure to hydrogenated fat rich in trans-fatty acids adversely programmed the hypothalamic feeding control mechanisms.[309] Monkeys fed trans-fatty acids gained significant weight and abdominal fat even without excess calories and developed

prediabetes.[317] The Nurses Health Study, which tracked more than 84,000 women for 14 years, found a 30% higher risk for diabetes in those consuming the most trans fats.[318]

Cardiovascular Disease Risk and Trans Fat Intake

Cardiovascular disease is the greatest known disease risk associated with ingesting trans fats.[319,320] The World Health Organization Scientific Update found that TFAs had adverse lipid effects by increasing LDL cholesterol, inflammatory chemicals, and vascular endothelial dysfunction. There was a higher risk of myocardial infarction or heart disease death compared to any other fat including saturated fats.[321,322] Trans-fatty acids inhibited the formation of healthy phospholipid cell membranes in arterial cells in utero and inhibited conversion of essential fatty acids to polyunsaturated fatty acids. Both are risk factors in the development of coronary heart disease.[323] For every 1 gram per day increase in trans fat intake or 10 grams per day increase in saturated fat intake, artery walls thickened by 0.03 mm. Habitual intakes of saturated and trans fats are independently associated with increased atherosclerosis.[324] Trans fats increase LDL and decrease HDL in a linear and dose-related response.[325,326] Those with the highest intake of trans fats showed the greatest blood abnormalities and had the highest incidence of heart disease over a 6-year follow-up.[327] Healthy women (but not men) served 11 to 12 grams of trans fats per day from natural animal sources had significantly increased LDL cholesterol.[328] Both natural trans fat from beef and industrially created hydrogenated vegetable trans fats significantly elevated LDL cholesterol and lowered HDL cholesterol in healthy men who consumed high amounts of trans fats when compared to a low or moderate trans fat intake.[329] Eating a fast-food meal of high saturated and trans fats from a beef hamburger and a corn syrup–sweetened beverage increased LDL more than a meal of organic beef and a sucrose-sweetened beverage.[330]

Lowering the intake of trans-fatty acids by 5 grams a day reduces the incidence of coronary heart disease up to 20%. Food manufacturers and fast food outlets in The Netherlands, under pressure from consumers, made a major reduction in the trans fat content of foods. In 2006, McDonald's french fries in The Netherlands dropped to less than 4% trans fat, as opposed to 21% trans fat in the United States.[331] After implementing a law that limited trans fats in foods in Denmark, the typical fast food diet decreased from 30 grams a day in 2001 to less than 1 gram in 2005. The same menu of foods provided 36 grams of trans fats in the United States. Harmful trans fats were reduced without noticeable effect on availability, price, and quality of foods.[332] Dairy and meat are now the major remaining source of trans fats in Europe. TFA content in ruminants generally does not exceed 6%.[333]

The 2005 *Dietary Guidelines for Americans* recommend that trans fats be as low as possible in the diet. The WHO recommends no more than 1% of total calorie intake and the American Heart Association recommends no more than 2 grams per day of TFAs.[334]

Trans fat consumption in the United States dropped from 8 grams per day in the early 1980s to 6 grams per day in the late 1990s.[335] Foods commonly purchased between 1994 and 1996 were analyzed for trans-fatty acid content, which ranged from 0 to 7 grams per serving. Of the foods analyzed, the results showed that trans fat occurrence was highest in breads and cakes (up to 49 g/100 g fat), margarines (15 to 28 g), cookies and crackers (8 to 35 g), frozen potatoes (25 to 38 g), salty snacks (0 to 17 g), and vegetable oils and shortenings (0 to 13 g). There were small amounts in some salad dressings, mayonnaise, and dry breakfast cereals. Meat and dairy products were not analyzed.[336] The National Food and Nutrient Analysis Program conducted a preliminary sampling of reformulated products in 2006. "Trans fatty acids in margarine decreased from 20 g/100 in 2002 to 15 g/100 in 2006 for 80%-fat stick margarines and to 5 g/100 g for 80%-fat tub margarines." As food manufactures reformulate products to reduce and eliminate TFAs, samples will be monitored as funds permit.[337]

Consumption data requires comparison over time. Lower food content does not reflect changes in consumption habits. It is difficult to determine the amounts of TFAs consumed in the population and in what foods because "food composition databases with TFA data are either nonexistent or incomplete."[338,339] By 2005, the FDA estimated that the daily average U.S. intake was still 6 grams[340]; however, in North America, daily intakes of trans fats have been estimated by food frequency questionnaires to be 3 to 4 g per person and by extrapolation of human milk data to be greater than 10 g/person.[341] Forty percent of the trans fats eaten are in baked goods, including cookies, cakes, and pies. The other major sources of trans fats come from animal products (21%), margarine (17%), and fried potatoes (8%).[340] Home use of margarine appeared to be a significant contributor to plasma trans-fatty acid levels.[342]

After over 15 years of working to eliminate trans-fatty acids from foods, the Center for the Science in the Public Interest (CSPI) was able to get the FDA to respond. With the scientific evidence associating trans-fatty acid (TFA) intake with an increased risk of coronary heart disease, the U.S. FDA issued a final rule that required the declaration of the amount of trans fats present in foods, including dietary supplements, on the nutrition label by January 1, 2006. In the U.S., products containing less than 0.5 g of TFA per serving may be declared as containing zero trans fats.[299,343] In Canada a trans-free product "must contain less than 0.2 g of trans fat per serving and must also be low in saturated fats."[344] The new nutrition labels are expected to prevent 600 to 1200 cases of heart disease and 240 to 480 deaths each year, saving $900 million to $1.8 billion per year in medical costs, lost productivity, and pain and suffering. On the basis of relationships of TFA intake with coronary heart disease (CHD) incidence in prospective studies, 21% to 39% of CHD events would be prevented by replacing TFA with monounsaturates from canola and olive or polyunsaturates from soybean or sunflower.[345,346] There would be a 17% to 31% decreased incidence if people consumed butter and other naturally saturated fats rather than trans fats.[345]

Restaurants were a major source of artificial trans fat, but customers had no practical way to know whether food they ate contained it. Food service workers cannot answer the question, because they are untrained in reading labels or in basic nutrition. In December 2006, the New York City Board of Health voted unanimously to require that all city restaurants must reduce trans fats in foods to less than 0.5 grams per serving by July 1, 2007.[347–351] Violations of the laws may come with penalties. New York City's Health Department fined non-compliant restaurants up to $2000 in October 2007 for not complying with the new law. Most were still using trans margarines.[352]

Other cities, counties, and states soon proposed similar legislation. California became the first state to make its restaurant foods free of artificial trans fat in 2008.[353] In contrast, the Pennsylvania Trans Fat Task Force suggested statewide public education and voluntary compliance from the food industry rather than enact prohibitive regulations. They were concerned that "legislation imposing deadlines for eliminating them may force restaurants and food companies to switch to equally unhealthy alternatives just to meet the deadline."[354] There are no standard regulations for schools. The USDA Nutrition Service, through the MyPyramid campaign, recommends that "schools should serve little or no trans fats and to talk to vendors about trans free choices." The USDA provides many products to the school system and has "eliminated trans fats from its frozen potato products and eliminated solid shortening in its bulk commodity foods." Other foods may still contain trans fats.[355]

As laws changed and as consumers made more informed choices, most restaurants, fast food outlets, cruise ships, and food manufacturers modified their food products.[356,357] According to the CSPI, the amount of added TFAs in foods declined by more than 50 percent between 2005 and 2009.[358] Products claiming "no trans fat" accounted for 13 percent of all new food product introductions in 2007.[359]

McDonald's, Wendy's International, and Taco Bell began lowering and eliminating TFAs in most foods between 2007 and 2008. McDonalds' European outlets were to switch to 2% or less trans frying oils by mid 2008.[360] KFC stopped using TFAs for deep-frying in 2007 after CSPI sued the company, though the biscuits and pot pies still had high amounts.[361,362]

Burger King at first refused to lower its trans fats and was sued in 2007 by CSPI. Burger King's lawyers fought back and lost. In 2008, Burger King Corp. announced it would begin using trans-fat free cooking oils at all of its U.S. chains and that it's baked goods would contain zero grams.[363,362] Unilever, who makes half the soft margarine spreads sold in the U.S., planned to reduce trans content by 2010 with a palm oil mixture.[364]

Reducing TFAs in foods is a complex issue. The goal is to do so without increasing saturated fats "while maintaining functionality and consumer acceptance." The greatest concern is that fats and oils high in saturated fats, instead of the healthier unsaturated fats, might be used to replace trans fatty acids as restaurants and food manufacturers meet legislated deadlines.[365] Polyunsaturated oils with no trans fat can be used for frying, but creating a flakey baked product requires a saturated fat. There is not enough appropriate oil sources to meet current demands of replacing partially hydrogenated fats. It is important that regulatory actions be coordinated with supplies of healthy oils rather than with saturated fats and tropical oils. Appropriate sources should be low in saturated fat, high in cis-unsaturated fatty acid, handle high temperatures, and produce edible products.[366]

Companies are usually switching from TFAs to cheap, highly saturated tropical plant oils: palmitic acid from palm kernel and lauric from coconut and palm kernel oil. Both trans and saturated fats are related to cardiovascular disease, but trans fat promotes greater synthesis of LDL and total cholesterol and lowering of HDL.

Three different margarines made from palm oil (saturated), partially hydrogenated soybean oil (trans), and a polyunsaturated oil [polyunsaturated fatty acid (PUFA)] were compared for effects on indices of heart disease. Fat content in the diet was similar for all participants. Both trans and saturated fat elevated total cholesterol, LDL cholesterol, and markers of inflammation, such as, apolipoprotein B. The polyunsaturated oil significantly lowered these harmful products. HDL cholesterol was similarly high with the PUFA and palm oils and much lower with the trans oil.[367,368] HDL cholesterol was lower when consuming trans fat margarine compared to lauric acid margarine.[369] Palmitic and lauric acids appear to be a more heart healthy alternative when one requires a hard, saturated fat in foods, but they are not as healthy as using nonhydrogenated poly- and monounsaturated fats. Palmitic and lauric fatty acids still show evidence of elevating LDL cholesterol.[370]

Another method of lowering trans fats may be in the way the liquid oils are treated in the hydrogenation process. The USDA is producing spreadable, hydrogenated fats with significantly less trans-fatty acids by heating the liquid soybean oils at lower temperatures, at higher pressures, and with different catalysts. These margarines and shortenings are not trans-fat free, but meet the new FDA requirements.[371]

Developing new and adequate supplies of oils takes time. Conventional oils are in limited supply. Through genetic engineering and plant breeding techniques, some seed oils have been modified for a targeted fatty acid composition. These have a long shelf life, can be used for frying, and have no trans fats. A new genetic variant of soy seeds were developed in 2005. The first crop was planted in 2007 to deliver 1 billion pounds of low-linolenic oil, which leaves food tasty without trans and saturated fats.[372]

A final method blends a saturated hard fat with liquid oils to produce fats with intermediate characteristics that have no trans fats. The molecular structure of the fat is such that it often is not absorbed by or stored on the human body. Many products are made with medium chain triglycerides or fortified with omega-3, omega-6, and plant sterols. They are being marketed to reduce body weight and help lower LDL cholesterol.[370] A new margarine Novarin replicates the characteristics of saturated fat in puff pastries and croissants without providing saturated or TFAs. The developer did not reveal details of the technology and ingredients. It is already sold in several countries.[373]

Seven months after the new labeling law went into effect, a survey of food labels indicated that most margarines and butters (21 of 29), cookies and snack cakes (34 of 44), and savory snacks (31 of 40) were labeled as containing 0 g trans fat. However, the remainder contained significant levels (>3 grams/serving) of trans fats.[374,375] By 2006, healthy sunflower, corn, and canola oils were used in 56% of reformulated "no-trans" chips, but 45% of reformulated "no-trans" cookies switched to unhealthy saturated fats from palm, coconut, or butter.[376]

The cheaper products tended to contain the highest amounts of trans and saturated fats. Those products with nutrient health claims tended to be more expensive. Higher costs for healthier products negatively impact health risk for the poor or less educated population.[374,375]

Public Health Interventions to Reduce Trans-Fatty Acid Intake

Although public education is considered the cornerstone to reducing trans fatty acid consumption, there are several issues that hamper major changes in behavior. There is lack of understanding, reading, and complying with educational efforts. The American Heart Association "Face the Fats" national campaign started in 2007. After one year, consumer awareness of trans fats increased from 84% to 92%. The awareness of the trans and hydrogenated fat relationship to heart disease increased. But only 21% could name three food sources of trans fats. Consumers who altered shopping behavior and purchased foods with the "zero trans fat" on labels increased from 32% to 37%. The plan is helping, but overall knowledge about trans fats still remained low.[377] There is decreased interest in reading labels and changing buying patterns. Compared to 1996, adults using the Nutrition Facts panel on foods "always or often" declined from 50% to 38% by 2006. Twenty seven percent say they "never use" the facts panel compared to 22% ten years before.[378,379] There is little information about trans fat content where legislation is lacking. Mandatory labelling of TFAs does not apply to restaurant, cafeterias at work or school, and fast food chains where most trans fats are consumed. In general, these meals tended to be less healthy overall and with higher trans-fat content.[380] Certain groups, such as children, low income, lower education, and young pregnant women do not understand how to choose affordable, low trans, healthier foods.[381] They make unhealthy food purchases not knowing that similarly priced, but healthier foods are available from the same location.[382,383] And lastly, some consumers may confuse the "zero-trans" label as a reason to eat more of a product because they think it is now a "healthy". Many may still consume high

amounts of TFAs and not know it. For example, a zero trans product may contain 0.49 grams per serving. Eat 4 servings, and the actual intake is almost 2 grams of TFAs. That practice can lead to a significant and unhealthy daily intake. This loophole needs to be eliminated to reflect true zero trans fat foods.[384,385,386,387] The Department of Nutrition, Harvard School of Public Health, feels that labeling is not enough and that "the present U.S. Food and Drug Administration position of allowing TFA in the food supply is indefensible and large numbers of Americans are dying prematurely because of its failure to act responsibly."[319,388] In fact, by allowing companies to label a product with trans fats as zero trans misleads consumers. No amount of trans is considered safe.

Public health interventions must include:

- Educate individuals or small groups about reading labels and making food choices. This can be done in a classroom, during a routine visit to a health care provider, through a community center, or at the workplace.[389]
- Develop stronger labeling and food manufacturer criteria. For example, eliminate foods with trans fats or put "contains trans fats" on the front of packaging.
- Continue to develop safe and healthier alternatives when hard fats are needed in a recipe.
- Encourage the use of liquid oils and omega-3 fats to offset the unhealthy effects of trans fats.
- Act as advocates and role models for healthier foods and meals in one's own workplace, home, or stores.
- Provide a list of alternatives to trans-fat foods.
- Write to food manufacturers regarding why you did not purchase their product and make suggestions for removing trans fats.
- Require cafeterias, restaurants, and catering companies to label what is in their foods or provide educated employees on site to answer questions.
- Support legislative efforts to remove all industrially created trans-fatty acids from the food supply and replace with acceptable, healthier fats.

OBESITY

Obesity may soon surpass smoking as the leading cause of preventable death in the United States.[390] The three Healthy People 2010 goals for prevention and control of childhood obesity include decreasing the consumption of energy-dense, high-sugar/high-fat foods like soda, ice cream, junk food, and fast food and increasing the consumption of nutritious foods like fruits, vegetables, whole grains, and skim milk. This is to be achieved by improving school education about nutrition. The goal to create social, monetary, and policy-driven incentives that reinforce long-term environmental and behavioral change will improve food security for impoverished households. Poverty and low income has been related to obesity in the United States because this group tends to consume the cheapest foods, which are high in sugar, fat, and calories, and have little nutritional value.[7,391]

Sixty-two to sixty-six percent of Americans were overweight (>30 pounds over the ideal body weight) in 2000, up from 46% in 1980. Twenty-seven to thirty-three percent of the overweight group was considered obese, twice that of 1960.[155,392–394] In 1999, 14% of children and adolescents were overweight. By 2003–2006 the number had increased to 17% of all U.S. children and adolescents.[395] Among men, the prevalence of obesity has increased significantly. In 1999–2000, 28% of men were obese. By 2003–2004 male obesity had increased to 31%. The prevalence of obesity among women remained at 33%. Morbid or extreme obesity prevalence (body mass index ≥40) in 2003–2004 was 3% in men and 7% in women. Obesity incidence remains significantly higher among non-Hispanic White (30%), non-Hispanic African American (45%), and Mexican Americans (37%) adults. Among adults ages 20 to 59, older age predicted greater numbers of obese individuals.[396]

Bariatric surgery increased 10 fold between 1993 and 2004[397] exceeding 120,000 procedures in 2003 with a projection of 205,000 to 218,000 annually between 2007 and 2010.[398,399] "Bariatric procedures peaked in 2003 and have since plateaued. The estimation of case volumes is limited by deficiencies in data and nonuniform search criteria."[400] Gastric bypass procedures accounted for more than 80% of all bariatric surgical procedures.[399] These surgeries increase medical costs at about $25,000 per procedure.[401] Mortality rates have decreased from about 5%[402] to 0.1% to 1.11%.[403–405] Perioperative complications occurred in 4% to 9%.[403,404] Bariatric surgery appears to increase survival even in the high-risk and older patients.[406] Many obesity related disorders, such as, sleep apnea, diabetes type II, hypertension show significant improvement after bariatric procedures.[401]

Multiple factors can account for weight gain, but basically, people eat more energy than they expend (i.e., too many calories and too little exercise). In an 8-year

prospective study of over 50,000 women, eating a diet high in energy-dense foods containing saturated fats, trans fats, and refined carbohydrates with a high glycemic index caused greater weight gain than in those eating low caloric foods of vegetable protein, vegetables, and fruit.[407]

Americans are consuming more food and several hundred more calories per person per day and have larger bodies, greater fat mass, and higher incidence of related diseases when compared to the 1950s. Only 13% of Americans say they are concerned about their caloric intake. They are "very" or "somewhat" concerned about their intake of fat (49%), sugar (18%), salt (17%), and cholesterol (16%).[155] In 2005 the average daily caloric intake was 2700 (after accounting for food wastage) compared to 2200 calories in the 1970s and 1900 in the late 1950s. The 25% increase in calories between 1970 and 2005 was mainly from refined grains (41%), added fats and oils (32%), and added sugars (19%).[155] Dairy, fruit, and vegetable consumption rose, but they are still below the 2005 U.S. Dietary Guidelines. Meat, eggs, and nut consumption increased by 8% and intake is greater than recommended by the Dietary Guidelines.[408] Refined grains and sugars increase the glycemic index of foods. The glycemic index measures the elevation in blood sugar after a meal. High glycemic index diets appear to increase body weight, body fat mass, and waist circumference, especially in sedentary women.[409] In overweight individuals, high glycemic loads appear to increase inflammatory markers, increasing adverse symptoms of diabetes, heart disease, obesity, and other inflammatory disorders.[410] When children and adults were served a high glycemic index breakfast of a refined carbohydrate, they reported greater hunger and ate more calories at lunch compared to a low glycemic index breakfast with more protein. The low glycemic index breakfast produced greater feelings of fullness for up to 36 hours. Body weight and gender did not have a significant effect.[411–413] Normal weight men served a low glycemic carbohydrate meal reported decreased appetite and hunger that was better and longer than a similar, isocaloric fatty meal. Dietary fat could therefore lead to passive over-consumption of energy-dense foods.[414]

The insulin elevation caused by different foods may increase subsequent hunger more than the glycemic response.[413] Mice fed a high glycemic index diet had 40% greater body fat and significantly greater insulin resistance at the end of the study compared with mice fed the low glycemic index diet. The high glycemic–fed mice had less fat oxidation and performed 45% less physical activity.[415] Adding alcohol to a meal also suppressed fat oxidation compared to isocaloric meals rich in protein, carbohydrates, and fat.[416] Lowering the glycemic load improved insulin sensitivity, lowered fasting blood triglycerides, and helped in weight loss. Lower glycemic index meals are one means of reducing the risk of diabetes and coronary heart disease.[417]

The portion size of foods is increasing. Most commonly available food portions exceed the USDA and FDA standard portion sizes, and most foods are available in larger portion sizes than they were in the 1970s.[418] A sample of common foods ingested by over 63,000 individuals over age 2 years was taken from three national food intake surveys between 1989 and 1998 to determine trends in portion sizes. These foods combined represented 18% of all kilocalories consumed in 1977–1978 and 28% of all kilocalories consumed in 1994–1996. "The largest portions were consumed at fast food establishments and the smallest portions at other restaurants. Between 1977 and 1996, food portion sizes increased both inside and outside the home for all categories except pizza. The energy intake and portion size of salty snacks increased by 93 kcal, soft drinks by 49 kcal (13 to 20 fl oz), hamburgers by 97 kcal (5.7 to 7.0 oz), french fries by 68 kcal (3.1 to 3.6 oz), and Mexican food by 133 kcal (6 to 8 oz)."[262,419]

Beverage choice plays a significant role in caloric intake and risk of obesity. Increased beverage consumption of any kind other than water was associated with an increase in the total energy intake in children.[215] Drinking water is the recommended beverage followed by tea, coffee, 1% and nonfat milk, and soy beverages, in that order. Calorically sweetened, nutrient-poor beverages should be consumed last.[420] However, Americans are consuming larger portions and more servings per day of sweetened beverages. "An increase in daily intake of 150–300 kcal from beverages has occurred along with the increase in obesity. Approximately 50% of the increased calories come from the consumption of calorically sweetened beverages."[420] "The percentage of calories from beverages, mostly sugar-sweetened, significantly increased from 1965 (12%) to 1977 (14%), 1988 (19%), and 2002 (21%)."[421] Children ages 6 to 11 years had a 20% increase in calories from sugar-sweetened beverages and 100% fruit juice between 1988 and 2004.[149] Consumption of sugar-added beverages may contribute to weight gain among adolescents, probably due to their contribution to total energy intake.[213] In a 4-year study of over 6000 adults, soft

drink consumption was associated with a higher prevalence and incidence of multiple metabolic risk factors. Having one or more soft drinks per day, compared to no soft drinks, increased the risk of developing metabolic syndrome by 44%; developing obesity by 31%; increased waist circumference by 30%; impaired fasting glucose, high blood pressure, and elevated triglycerides by 18–25%; and lowering HDL cholesterol by 32%.[203] Reducing soft drink and fruit drink intake would seem to be one of the simpler ways to reduce obesity in the United States.[161] Drinking large amounts of milk also may provide excess energy to some children. In a 4-year study of almost 13,000 children, those who drank the most milk gained more weight.[422] However, low-fat milk also supplies calcium and whey, which may decrease weight gain and increase fat loss.[423–425]

The proliferation of large portions of snack and fast foods parallels the dramatic increases in childhood obesity. A survey of almost 5000 children indicated a preference for portions of french fries, meats, and potato chips that are larger than recommended. Vegetable portions were smaller than recommended. The largest portion sizes occurred in those children who were from poorer families, who frequently ate while watching TV, and who ate in fast food restaurants. This pattern of eating led to poor diet quality and increased energy intake. Consuming large portions of vegetables was associated with lower caloric intake and better diet quality.[426]

Children served a lunch entrée that was twice the age-appropriate size increased their entrée calorie intake by 25% and their total energy intake by 15%. The children were unaware of the increased portion size. Children ate 25% fewer calories when they were allowed to serve themselves.[427] An energy-dense entrée added 76% more energy from the entrée and 34% more energy at the meal when served in the larger portion size. Effects did not vary by sex, age, entrée preference, or body mass index.[428] Two versions of a macaroni and cheese entrée were formulated to differ in energy density. Children ate significantly more of the lower kcal meal, but decreasing the energy density of the entrée by 30% resulted in a reduction in children's energy intake from the entrée. Energy derived from the total meal decreased by 18% when served a lower kcal entrée. Reducing the energy density by serving low fat foods or more vegetables may be an effective strategy to moderate children's caloric intake.[429]

Adolescents are normally aware of their body size and shape and are somewhat interested in making improvements. They tend to have more control over their food intake and lifestyle behaviors than a younger child. Among low-income, urban, African American adolescents, 55% had fried foods two or more times a day and 70% had two or more soft drinks daily. Only 26% reported 20 minutes or more of moderate to vigorous exercise in 5 or more of the previous 7 days. Twenty-nine percent spent 5 or more hours each day watching TV, playing video games, or using the computer.[430] Teens said they would be willing to exercise more, to change eating habits to include more fruits and vegetables, to drink more water, and to eat less junk food, but they would not be willing to give up soda, video/computer games, and watching television to improve their health.[431] In a pilot study, adolescents who regularly consumed sugar-sweetened beverages were given noncalorie beverages for 25 weeks. This simple intervention almost completely eliminated sugar-sweetened beverage consumption and showed a beneficial trend towards lower body mass index.[432]

Seventy-four percent of U.S. adults report that they do not engage in the amount of leisure time physical activity recommended by the U.S. Department of Health and Human Services. The percentage of students attending daily physical education classes decreased from 42% in 1991 to 32% in 2001.[433–435]

In order to decrease the prevalence of obesity, a multifaceted public health approach is required to address the many behavioral, sociocultural, and environmental factors that promote caloric intake and discourage physical activity.[436,437] In 2001, the *Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity* was issued to provide the framework for an approach to encourage exercise and decrease calorie consumption.[390] To make the public more conscious of their nutrient intake, public health interventions might make labels reporting the calorie and nutrient content of foods more prominent and pervasive. Several states are adopting requirements for fast food restaurants to post the calorie content of their foods next to the menu. Other strategies include encouraging the sale of more healthful foods in fast food restaurants, tax incentives, and limiting the sale of high-calorie, low-nutrient snacks on school campuses.[438]

There are several comprehensive staged-care approaches for weight management that include prevention, structured weight management, comprehensive multidisciplinary intervention, and tertiary care intervention. Health care providers can encourage healthy behaviors while using techniques to motivate patients and families, and use interventions tailored to the individual.[439]

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CHAPTER
6

CHAPTER OUTLINE

Care for Work-Related Musculoskeletal Disorders: Implications for Public Health

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WORK INJURY AS A PUBLIC HEALTH ISSUE

Health care delivery settings frequently take the care of injured workers for granted, if they even accept workers' compensation cases at all. Medical, osteopathic, and chiropractic schools rarely have more than a couple of lectures on the subject built into their curricula, and although specialty residencies and certification programs exist, the emphasis is frequently directed at aspects of occupational injury and disease that are rare (e.g., black lung and asbestosis) or related to something that has a lower maintenance revenue stream associated with it (e.g., preemployment screening, ergonomic consultation, drug screening).[1] Taking care of injured workers typically comes with more administrative burden than other forms of insurance reimbursement, and any number of social and regulatory artifacts get in the way of "usual" patient care. For example, employers often get to have a say in treatment and health care benefits can seem to be more employment oriented than they are clinically driven.

During 2006, a total of 4.4 million occupational injuries and illnesses were reported by employers in the United States.[2,3] Of that number, 2.3 million required time loss or work restrictions in order to recover. These numbers represent only those acknowledged by employers to be work related. Over the past decade, the number of reported work injuries has decreased by almost a third, attributable to several factors including improved health and safety efforts by regulators and companies, technological advances in the workplace, and shifts toward a more service-based economy. Additionally, variations in workers' compensation practices and requirements, underreporting, and other factors may affect these data. However, in recent decades, employers' workers' compensation costs have increased from just over $2 billion in the 1960s to more than $62 billion in the 1990s.[4] The rise in medical cost per injury in the United States increased an average of 14% per year during the 1980s compared to an 8% rise in the medical component of the Consumer Price Index.[4] Although low back pain is the most prevalent occupational condition, and is by far the most disabling, only a small number of these cases progress to chronic disability.[5] Amazingly, fewer than 10% of all injured workers account for more than 80% of total costs.[6]

However, the system costs for workplace injuries pale in comparison to the human costs. Nearly 70% of workers in Washington State who underwent spinal fusion surgery for their occupational low back problem remained disabled 2 years following their surgery.[7] What is particularly troubling is that aside from a catastrophic injury, the severity of the original back injury has little to do with whether a person becomes chronically disabled from it. Workers who do not return to their jobs within the first couple months of their injury are unlikely to ever return to productive employment.[5] Losing the ability to earn a living, the inability to perform daily activities without pain, and damage to personal and family life might be comprehendible from a catastrophic spinal cord injury, but from an "uncomplicated" low back sprain? And the problem continues to worsen with an increasing proportion of persons with occupational low back injuries becoming disabled.[8] Truly, occupational injury, even from occupational low back pain alone, is a public health disaster by anyone's measuring stick.

HISTORY OF WORKERS' COMPENSATION

Although workers' compensation insurance has all the trappings of a health care benefit, the reality is that modern systems have evolved from, and in great measure continue to be dictated by, the politics surrounding employer and labor interests within a given jurisdiction.[9] In essence, workers' compensation benefits reflect political compromises negotiated through legal and regulatory frameworks, and generally constitute a no-fault liability system. Regulation of the system happens at the governmental level, federally in many countries and state by state in the United States. Thus, the specifics of what health care benefits are available to injured workers, how they are accessed, and how workers are compensated is often the subject of political negotiation at a legislative level. This has led to substantial variation among states, provinces, and countries regarding how programs are administered, what services are reimbursed, and whether a patient or their employer gets to "direct" the care provided.

Although the relationship between unhealthy workplace environments and illness or injury has been recognized at least since the time of Hippocrates, historically speaking, workers' compensation laws are a recent development. Perhaps the earliest documentation of the dangers of work-related health problems was made by Ramazzini in 1713 in a work entitled *The Diseases of Workers*.[10] Social concern for compensating an injured worker is not new, nor is it unique to industrialized societies. One of the earliest systematic social policies to compensate workers for their injuries has been traced to the society of seafaring pirates operating in the Western Hemisphere.[11] For example, the policy delineated 600 pieces of gold to be paid for the loss of a right arm and 500 for the loss of a left, slightly less for the loss of a leg, and a mere 100 pieces of gold for loss of an eye or a finger in the course of pirately duties.

Throughout the 1800s there was an increasing recognition of a relationship between work and the frequency and severity of certain injuries. The absence of judicial recourse prompted calls for regulatory remedies.[12] Early in the 19th century, precedent and case law seemed to blame employers for work injury where "the act of the servant was the act of the master," laying all economic consequences on employers.[12] This resulted in employer activism for reforms. Arguing that employment by its very nature is for the social and community good, cultural perceptions changed, and the pendulum swung toward blaming work injuries on workers' negligence, thereby holding them personally responsible for injuries they may have contributed to. This was codified in a regulation from England in 1837 known as the *Fellow Servant Doctrine*, under which a worker could not recover damages or benefits from an employer if the injury was due to a coworker's negligence.[13] The United

States followed with the legal decision of *Farwell v. the Boston and Worcester Railroad* in 1842, in which the railroad was held immune from liability for injuries that resulted from the negligence of the company's switchmen.[14] This common law was propelled by social beliefs that employer liability was counter to the general economic good of modern industrialized societies.

EVOLUTION OF THE COMPENSATION ERA

Table 6-1 illustrates the kinds of historical classifications used in early 20th-century Germany based on who was determined to be at fault.[14] In great measure, common law defenses throughout the mid-19th century favored employers for all but those work-related injuries that could be directly attributed to the fault of the employer, probably less than 20% of all industrial injuries.[14] Eventually courts began to set the pendulum swinging in the other direction. The most that earlier laws ever seemed to accomplish was to treat employees in a manner similar to a stranger who may have been injured in the course of negligence by an employer or one of his servants. In the United States, for example, the state of Georgia was the first to enact a statute in 1855 that abrogated the "fellow servant" defense for railroad companies operating in that state. The 1880s saw an Employer Liability Act in England that attempted to rectify the problem, but loopholes allowing workers to sign contracts that waived rights and made it ineffectual.[14] The U.S. Federal Employers Liability Act of 1908 applied several of the protections embodied in many of the state acts up to that time to workers involved in interstate commerce.

The index year for modern workers' compensation systems was 1884, with formal establishment of a workers' compensation program in Germany. England followed 13 years later, a full 25 years before the first U.S. state (Massachusetts in 1904), and some 75 years prior to the last U.S. state (Mississippi in 1949) enacted similar legislation.[14] By 1950, an estimated 77% of the total U.S. workforce was covered. Penetration of workers' benefits plans remained stagnant, rising only one percentage point by 1960.[15] In 1970, the National Commission on State Workmen's Compensation Laws was established by the U.S. Congress to recommend a set of minimum standards for every state. The commission was composed of representatives from business, labor, workers' compensation agencies, insurance carriers, medical professionals, and compensation experts from the academic community.[14] **Table 6-2** identifies essential characteristics of modern workers' compensation laws reflected in the commission's report.

Table 6-1 Historical Classifications of Causes of Industrial Accidents (listed from most common to least common)

- Inevitable accidents connected with employment
- Injured employee fault or negligence
- Employer fault or negligence
- Coworker negligence
- Injured employee and employer joint fault
- Acts of God

Adapted from: Larson A. *Workmen's Compensation for Occupational Injuries and Death*. New York: Matthew Bender; 1992.

Table 6-2 Characteristics of Modern Workers' Compensation Laws

- Compulsory coverage
- No exemptions to coverage
- Inclusion of domestic and agricultural workers
- Full coverage of work-related diseases
- Full medical and rehabilitation coverage
- No arbitrary limits on duration or total benefits
- Reasonable weekly time loss benefits exceeding average weekly wages

CHALLENGES OF CONTEMPORARY WORKERS' COMPENSATION SYSTEMS

Civilized society needs to provide remedies for workers whose health is adversely impacted in the normal course of their employment. However, despite the noble objectives, evolution of modern systems is not without problems. Medical inflation in workers' compensation typically is higher than the medical component of the Consumer Price Index, which often prompts dramatic cost containment and regulatory efforts.[4] Unfortunately, the urgent, and frequently political, approaches used to cut costs in the short term can have unintended downstream impacts that affect health care access and drive incentives that may impact health care quality and efficacy. Conversely, the sophistication of evidence-based practices and technology assessments has increased. More workers' compensation programs routinely incorporate these kinds of strategies to find an appropriate balance between the needs of injured workers and system affordability.

Outdated common law approaches to liability for workplace injury diminished incentives for employers to invest in workplace safety. However, comprehensive

regulations that protect workers contribute to complexities in the management of work-related injuries. Responsibility for health care and economic security is blurred between individuals and the employer as a function of the extent and type of social program and the culture that has been established in each jurisdiction. Incentives for compensating injured workers who are not working, especially when one is employed in an undesirable occupation or setting, also contribute challenges and perverse incentives. Doctors can often be placed in roles dictated more by regulatory requirements and employer–employee relations than by clinical need.

Reimbursement incentives are also frequently perverse. For example, it is pretty straightforward and common in workers' compensation to obtain advanced imaging studies such as magnetic resonance imaging (MRI) early in the course of a low back pain claim. However, evidence is pretty clear that advanced imaging in the absence of specific clinical circumstances leads to more downstream utilization of medical and surgical services of questionable benefit (and perhaps harm) to the patient.[7,16,17] Similarly, incentives for physical medicine services may be improper. Physical medicine services and chiropractic care are often covered as capped or limited benefits, which are simple to administer and/or adjudicate on. However, reimbursement distinctions are rarely made between active approaches known to have benefit and passive or palliative approaches that may be of little value.[18–20]

Particularly frustrating for doctors is that not only are there variations among state workers' compensation programs, but multiple federal workers' compensation programs also exist that are administered differently and have benefits, reimbursement structures, and documentation requirements that differ from each other and from state programs.[21] Thus, within a given state, there may be different private insurance carriers, state fund carriers, self-insured employers, union trusts, and multiple federal workers' compensation programs that all have their own ways of doing things.

IMPACTS AND INCIDENCE OF NONCATASTROPHIC, WORK-RELATED MUSCULOSKELETAL INJURY

The management and disability costs of occupational low back injury in 1990 were estimated to be a staggering $30 billion in the United States.[22] More recent estimates suggest the total direct costs exceed $90 billion annually,[23] with between $7 billion and $20 billion additional in indirect costs, well above inflation for the period.[24,25] Generally workers with occupational injuries fully recover and return to productive work. Unfortunately, in addition to the devastation they face, the small minority of people who do not recover from their injuries account for all but a small fraction of total costs.[26]

The direct medical costs for low back and neck pain exceed those for nonspinal conditions, and further, the rate of increase for spinal care is larger than that for other musculoskeletal problems.[7] In 1997 the direct medical costs for a back condition case were $4695, compared to $2731 for other conditions. By 2005 the amounts were $6096 and $3516, respectively. This reflected a 65% greater increase (above inflation) than overall health expenditures. Of additional concern, the estimated proportion of persons with back or neck problems who self-reported physical functioning limitations increased from nearly 21% to 25%. Age- and sex-adjusted self-reported measures of mental health, work or school limitations, and social limitations among adults with spine problems also increased over that time frame.[7]

In the United States, the U.S. Department of Labor's Bureau of Labor Statistics (BLS) documents annual trends in industrial injuries based on voluntary reporting by employers nationwide (**Table 6-3**).[2,3] Jurisdictional variation regarding what constitutes a workers' compensation claim, as well as limitations of the voluntary nature of BLS data, precludes extrapolation of these data to individual state workers' compensation experience. In 2006, there were 357,160 musculoskeletal disorder (MSD) cases reported with a median of 9 days away from work, 2 days longer than the median for all days away from work cases. The overall rate for all MSD cases was 39 per 10,000 workers in 2006. The trade, transportation, and utilities sector accounted for 34% of MSD cases, followed by the education and health services sector with 20%, the vast majority of these occurring in health care and social assistance occupations. Injuries within the manufacturing sector were responsible for 18% of the total. Reported MSD injuries in manufacturing decreased by 6% from 2005 to 2006, and occupationally related MSD conditions for all private industry decreased by 5%.

A look at specific occupations underscores potential exposure and confounder issues. Nursing aides, orderlies, and attendants had an incidence rate of 526 per 10,000 workers, which was more than four times the total for all occupations. Construction workers, freight workers, and stock and material movers, as well as

Table 6-3 Number, Incidence Rate, and Median Days of Work-Related Musculoskeletal Disorders That Required Days Away from Work by Selected Industry Sectors, 2006

	Cases in 2006	Incidence Rate/10,000 Workers	Median Days Away from Work per Case
Total musculoskeletal disorders	357,160	390	9
Goods-producing industries	103,750	460	10
Manufacturing	64,760	460	11
Service-providing industries	253,410	360	8
Trade, transportation, and utilities	119,770	540	11
Education and health services	72,020	550	6

Source: (USDL-BLSa 2007).

U.S. Department of Labor, Bureau of Labor Statistics. *Non-fatal Workplace Injuries and Illnesses in 2006*. Washington, DC: U.S. Government Printing Office; 2007.

U.S. Department of Labor, Bureau of Labor Statistics. *Occupational Injuries and Illnesses Requiring Days Away from Work, 2006*. Washington, DC: U.S. Government Printing Office; 2007.

heavy truck drivers, had rates above 400 per 10,000 workers. Men had a days-away-from-work rate of 143 per 10,000 workers compared to 106 per 10,000 women workers. Overall, MSDs accounted for 30% of the injuries and illnesses with days away from work in 2006, the same percentage as in 2005.

In addition to providing data on the number of injuries and illnesses that require days away from work to recuperate, the BLS survey provides data on the length of the absences resulting from those injuries and illnesses. Median days away from work (which reflects injury severity) was 7 days in 2006, unchanged since 2004. Almost one fourth of all days-away-from-work cases resulted in 31 or more days away from work. Fractures accounted for the longest median days from work (28 days), followed by carpal tunnel syndrome at 27 days and amputations at 22 median days away from work, both also unchanged from 2005. Repetitive motion resulted in the longest absences from work among the most frequent events or exposures, with 19 days away from work. Falls to lower level had 14 days, twice the 2006 median for all cases.

Floors, walkways, and ground surfaces were the sources that resulted in the longest absences from work, with a median of 11 days, followed closely by worker motion or position (10 days) and vehicles (9 days). Injuries and illnesses to the shoulder resulted in the longest absences from work, with a median of 16 days, followed by the wrist and knee, each with a median of 14 days. Workers age 65 or over experienced the longest absences from work with a median of 15 days, followed by workers ages 55 to 64 with 12 days and workers ages 45 to 54 with 10 days.

The body region most affected by work incidents in 2006 was the trunk (including the shoulder and back), accounting for 34% of all cases; however, cases involving the trunk decreased by 6% from 2005. Injuries and illnesses to the back made up 62% of the days-away-from-work cases involving the trunk. Overall, both the rate and the number of occupational injuries and illnesses requiring days away from work decreased from 2005 to 2006.[3] The 2006 rate was 128 per 10,000 workers, a 6% decrease from 2005. There were 1.2 million cases requiring days away from work in private industry, which represented a decrease of 51,180 cases (or 4%).

Sprains and strains continue to be the leading nature of injury and illness in every major industry sector, but reflect a 6% decrease from 2005 to 2006, a trend that appears to have sustained for a number of years. The overall number of cases of carpal tunnel syndrome also reflects a 21% decrease, which was even greater for workers who had been on the job over 5 years. All of this reflects a turn-around from previous years, indicating that injury prevention efforts have made progress. It also should be noted that various economic and overall industry sector shifts also contribute to these trends. For example, the number of people employed in the logging industry, one of the most high-risk job categories, has decreased substantially in recent years.

CHIROPRACTIC EXPERIENCE IN WORKERS' COMPENSATION

Chiropractors have long advocated their approach to injury care and prevention as a useful intervention that

facilitates return to work because it is directly geared toward improving function and good ergonomics.[27] In addition, doctors of chiropractic (DCs) have often touted lower total costs of injured worker care for their services based on early actuarial reports comparing chiropractic and medical costs. Fourteen of 17 retrospective actuarial studies from 14 different jurisdictions in the United States prior to 1981 concluded that the total costs for injured workers managed by chiropractors were lower than similar cases managed by other providers.[28] The savings did not always reflect lower professional cost, but reduced wage replacement cost due to shorter durations of time loss. Decreased utilization of hospitalization and advanced diagnostic services sometimes accounted for the beneficial economic differences in reaching a common clinical endpoint.

More recent reviews, frequently employing better actuarial study designs, have also demonstrated that use of chiropractic services correlates with lower medical and disability costs.[29–35] However, all studies to date do have significant methodological limitations. One recent review pointed out that although existing literature suggests that DCs and MDs provide equally effective care for low back pain (LBP) and that chiropractic patients are more satisfied with their care,[36] the limitations in high quality cost data, adequate sample sizes, and controls for confounding factors preclude making definitive conclusions about cost comparisons.[37]

A review of 10,000 claims in Utah noted that use of a managed care chiropractic benefit resulted in a much lower rate of increased costs for managing nonsurgical back conditions than did medical management over a 3-year period.[38] Direct care costs in workers seen by chiropractors increased 12% while disability costs increased by 21%. The comparable group of patients managed medically saw an increase of 71% in direct costs and 114% in disability costs. In Washington State, injured workers who see chiropractors first appear to be at substantially lower risk of being disabled a year after their injury (using multivariate analysis that accounted for severity, age, industry, etc.).[39]

Turning to cost and utilization data outside of workers' compensation settings, patients using chiropractors are consistently associated with lower utilization of other medical services including prescriptions, radiographs and MRIs, surgery, and hospitalizations.[40–44] However, an analysis of over 1000 cases of low back pain from the RAND Health Care Experiment showed that chiropractors had the highest mean outpatient costs of any other provider, but lower than the total costs of orthopedists when in-patient services were included.[45] It should be noted that the entire data set from this experiment was collected prior to the onset of managed care, which has dramatically impacted utilization and billing patterns. In the United Kingdom, a well-designed prospective four-arm trial randomized 1334 patients to 12 weeks of either medical care, manipulation, exercise, or exercise/manipulation combination.[46] Better functional improvement in the three physical medicine groups was demonstrated over best medical care. Manipulation followed by exercise and manipulation alone both provided a moderate benefit at 3 months and small benefit at 12 months, but exercise alone provided only a small benefit at 3 months and no benefit at 12 months. A companion cost analysis concluded that manipulation alone offered the best cost per quality adjusted life year over a 1-year period.[47]

At a minimum, there is a long-term, consistent trend that the effectiveness and costs of chiropractic care for low back conditions, including in workers' compensation settings, are at least comparable to other forms of physical medicine, and probably better than standard medical treatment both in workers' compensation and general health care settings.[37,48] Despite limitations in definitive scholarly design, at a policy level the case for making chiropractic services available as part of workers' compensation is actually quite robust. Practically no studies or models have consistently indicated that outcomes are worse or costs higher under chiropractic care; the overwhelming trend is just the opposite. Specific utilization data by provider type is typically proprietary and resource intensive to come by. In addition, very few patients exclusively receive care from just chiropractic or medical personnel. Referral for consultation and physical/occupational therapy, and transferring attending doctors is common and confounds meaningfully costing-out by provider type. Further, insurers are frequently reluctant to discuss utilization and performance issues for business and legal reasons.

The key policy-level issues with chiropractic benefits in workers' compensation often reflect matters unrelated to clinical effectiveness or cost. Adjudication "hassle" and lack of common nomenclature can make chiropractors stand out. For example, most workers' compensation claims require that the accepted diagnosis be entirely work related. Chiropractors frequently make diagnoses and provide treatment in body regions that may not be directly involved in an injured area. Laws frequently allow employer-paid premiums to be used only for care of conditions directly linked to an accepted work injury or exposure. Pre-existing or concurrent conditions for which work-relatedness is unclear are flags for adjudicative intervention. A common example is when a worker

under chiropractic care for an injury is seen at a frequency comparable to their use of such service prior to an injury.

Inadequate documentation is another area where DCs are frequently cited as problematic. Indecipherable diagnostic treatment shorthand and minimal description of patient progress compared to when the treatment was initiated are common in chiropractic records, much more so than in medical or osteopathic physicians' records. Duration of care becomes an issue, especially because many states specifically only allow care that is curative or rehabilitative until maximal medical improvement is achieved. Further, studies of duration of chiropractic care for injured workers have not been able to document an increased benefit in recovery or time loss with longer durations of chiropractic care compared to shorter ones.[49]

Another critical flag relates to the substantial practice variation between chiropractors for similar kinds and severities of work injuries, more so than the practice patterns of other kinds of providers who treat the same kinds of patients and injuries. In addition to large differences in numbers and types of ancillary services provided, duration of care varies greatly from one DC to the next. Determining appropriateness of care, which is typically a legal obligation in workers' compensation, becomes challenging. Additionally, levels of chiropractic services are typically billed based on the number of body regions manipulated, yet there is no consensus for what is appropriate in a given situation (e.g., an upper cervical or Logan practitioner only needs to manipulate one body region regardless of condition, yet another needs to manipulate five regions regardless of condition or severity).

Although chiropractic as practiced at a population level is strongly associated with effective and at least comparable cost care for work injuries, chiropractic's intra-professional issues contribute to system friction, subjecting chiropractic services to increased scrutiny both at the case and overall benefits levels. Among these issues are nonstandard syntax and documentation conventions, significant practice variation, and a lack of professional guidelines as to what constitutes appropriate care in given clinical situations.

CHIROPRACTIC BENEFITS IN WORKERS' COMPENSATION SYSTEMS

Americans spend more money out-of-pocket for alternative and complementary health care than they do for hospital expenses not covered by insurance, workers' compensation, or other health care benefits packages.[50] Somewhere between 7% and 11% of the U.S. population reports using chiropractic services annually.[50,51] It may be substantially higher among workers' compensation patients. Estimates of the use of chiropractic care by low back pain and workers' compensation patients range from 10% to 40%.[31,52,53]

Coverage and benefits for chiropractic services are subject to substantial regional variation.[54,55] For the chiropractic profession, workers' compensation has been an important clinical and political issue due to the profession's significant emphasis on and expertise in the conservative management of musculoskeletal injuries. Additionally, workers' compensation makes up a small but significant proportion of chiropractors' practices.[56] Given that contemporary workers' compensation statutes and regulations reflect long-standing compromises among employer, labor, and workers' compensation administration interests, the extent to which chiropractic participation addresses all parties' interests determines the nature of chiropractic benefits.

Although specific workers' compensation benefits are often subject to change based on political priorities, chiropractic services are a common benefit in U.S. workers' compensation coverage. Chiropractic physicians are explicitly recognized by regulation or statute as attending providers in 39 states and the District of Columbia's workers' compensation systems and by more than 75 nations worldwide (**Table 6-4**).[55,57] Ten states do not delineate which provider types can or cannot be attending providers for injured workers. Workers' compensation regulations tend to be liberally construed in the workers' favor in most states. Canadian and Australian provincial regulations also allow chiropractic care for injured workers, but again specific restrictions vary considerably across jurisdictions. Patient access to chiropractic services for work-related injury is as diverse as the nature of national jurisdictions around the world.

BEST PRACTICES AND DISABILITY PREVENTION

Caring for injured workers must be done within the constraints of workers' compensation systems that are essentially the result of political compromises among business, labor, and social interests. At the system level, employer and labor interests are acknowledged as primary "owners" of workers' compensation, while providers are typically factored in as "service vendors" who are paid to provide the owners with worker care and medical information the system needs to fairly adjudicate benefits. This

Table 6-4 State-by-State Workers' Compensation Policy on Chiropractic as of 1997

States Explicitly Authorizing DCs as Treating Providers		States with Statutes that Do Not Designate Treating Provider
Alaska	Nevada	Illinois
Arizona	New Mexico	Indiana
Arkansas	New York	Maine
California	North Carolina	Maryland
Colorado	North Dakota	Minnesota
Connecticut	Ohio	Missouri
Delaware	Oklahoma	New Hampshire
Florida	Oregon	New Jersey
Georgia	Rhode Island	Pennsylvania
Hawaii	South Carolina	Vermont
Idaho	South Dakota	
Iowa	Tennessee	
Kansas	Texas	
Kentucky	Utah	
Louisiana	Virginia	
Massachusetts	Washington	
Michigan	Washington, DC	
Mississippi	West Virginia	
Montana	Wisconsin	
Nebraska	Wyoming	

Source: Jensen GA, Mootz RD, Shekelle PG, Cherkin DC. Insurance coverage of chiropractic services. In: Cherkin DC, Mootz RD (eds.). *Chiropractic in the United States: Training, Practice and Research*. Rockville, MD: Agency for Health Care Policy and Research, Public Health Service, U.S. Department of Health and Human Services; December 1997. AHCPR Publication No. 98-N002.

is in direct contrast to the traditional mindset of doctors who are used to being influential decision makers in the clinical process. All of these constraints contribute to what amounts to a concurrent condition that every worker has, which we'll call "systemosis":

> A condition where all those pesky pragmatics of a no-fault liability system established in law over 100 years of political compromise between labor and employer interest, attenuated by case-law, precedent, and bureaucratic inertia, get in the way of your business-as-usual clinical practice.

Any injured worker has their physical ailment or injury along with all the concurrent confounders that other patients have (biopsychosocial and personal issues, and other health care problems). In addition, they also present with the initially "clinically silent" disorder of systemosis. If left "untreated," systemosis can progress to delays, adversity, conflict, and demotivation, and eventually lead to poor patient outcomes. As with most any clinical condition, a majority of patients get better regardless of intervention strategies. However, if adversity in the workplace, family issues, financial issues, low recovery expectations, fear avoidance behavior, and/or deconditioning become burdens to the patient, their recovery suffers. Doctors are rarely trained in school or residencies to manage such artifacts or the consequences of how health care is paid for, a problem that increasingly factors in to what we can offer our patients. Usually providers simply become frustrated by what appear to be irrelevant administrative burdens. Some even consider the "administrivia" to not be their problem. However, there is a growing body of research that shows that doctors who tend to systemosis-like issues early in the care of injured workers end up with much better outcomes for their patients than those who do not.

Perhaps the most urgent systemosis issue is connection to and involvement of the workplace in a patient's recovery. Workers who do not return to work within a few months of having an injury rarely, if ever, return to productive work regardless of how severe the injury was.[5] The most powerful predictors of disability risk are

things outside of a doctor's, employer's, or patient's control: older age, being female, having a back or neck diagnosis, being divorced, working for a small employer, or being in a time of high unemployment.[5] Heroic, last resort clinical interventions rarely contribute to a meaningful, positive resolution.[7]

Obviously, preventing work injuries in the first place (primary disability prevention) is the best possible strategy. Data discussed earlier, as well as experience in many states, suggest that recent government and private sector efforts to improve workplace safety are paying off. When an injury does occur, however, preventing disability from it (secondary disability prevention) becomes the province of the worker, their doctor, their employer, and those involved in adjudication of the claim. The material presented here is most applicable to secondary disability prevention. Failures by any of the parties during this stage can derail recovery. A patient who fears they will be re-injured if they return to work, the doctor who's too busy to provide adequate documentation, an adjudicator who needs to make a legally defensible decision of the work relatedness of the condition, or an employer who is uninterested or unable to make accommodation for the patient to work during their recovery will all increase the likelihood of long-term disability. Minimizing the consequences of a disability once it has become established (tertiary disability prevention) is the least desirable and most ineffective path to recovery.

Once an injury occurs, the initial treating doctors are perhaps the best positioned of any of the parties to take the lead in preventing a worker from becoming disabled. They set the stage for the worker's own expectations of recovery, provide the care that facilitates healing, ensure timely communication with employers about what the worker is capable of, and document all the medical information that sets the stage for timely claim progress (e.g., occupational causation, workplace accommodation, determination of eligibility for time-loss payments). The doctor is also positioned to be the first in line to tell if progress is stalling and notify appropriate parties of particular needs such as assistance in returning the worker to their job. **Table 6-5** illustrates some key differences between general care and occupational health best practice care.

Several studies have documented 20% to 50% reductions in disability outcomes, such as time from injury to return to work and the proportion of injuries that require time loss, through the use of occupational health best practices by doctors.[58–61] These best practices primarily involve early communication and coordination with employers, establishing return to work as a key outcome, and ensuring timely attention is given to clinical and system needs.

A Canadian randomized controlled trial compared medical and disability costs for four different treatment arms: standard medical care, "best-practices" medical care (e.g., physical medicine, spinal rehab), standard occupational medicine care (e.g., regular employer communication, documentation of physical capacity), and best-practices occupational health care.[58,59] The latter group involved activities such as the doctor working directly with safety managers in the workplace, receiving a continuing education credit for occupational health

Table 6-5 Key Differences Between Occupational and General Health Practices for Musculoskeletal Conditions

General Health Model	Occupational Health Model
❍ Initial visit: Within days of initial contact to provider ❍ Diagnosis: Watchful waiting ❍ Outcome goals: Minimal focus on return to work ❍ Treatment dependence: May not be a primary concern	❍ Initial visit: Same day as incident ❍ Diagnosis: May need early rule out for attribution of work causation ❍ Outcome goals: Central focus on return to work, including ergonomic, job modification, and worker's physical capability to perform job tasks ❍ Treatment dependence: Avoiding dependence on prolonged palliative care and careful attention to functional improvement are key to preventing tertiary disability.

lectures and plant tours, implementing quality improvement teams in the clinic to track barriers to recovery and make appropriate treatment modifications, using a standardized work restriction form, and using a contact list for all parties to communicate appropriately. The total 6-year costs were lowest in the best practices occupational health care arm and were highest in the standard medical care group. Best clinical practices and usual occupational medicine practice also were significantly lower than usual medical care.

An ongoing community-based cohort pilot project in Washington State has documented substantial reductions in medical and disability costs along with reduction of administrative delays (which speeds payments to workers and providers) through the use of similar occupational health best practices along with community-based health care coordination services. Additionally, targeted financial incentives for doctors are used (employer phone calls, enhanced payment for rapid submission of accident reports, payment to complete a standardized activity prescription form that documents work status and other key elements of patient care).[62,63] Reductions in the number of people losing time from work and shorter durations of time loss were seen. In addition, employers and patients reported high satisfaction levels with the program and clinical care.[64,65] Doctors who participated were more satisfied with their experience and were more willing to treat workers' compensation patients. Of further interest, workers seen by doctors voluntarily participating in the program filed fewer appeals and required fewer vocational services over the long term.[65] Subsequent evaluation indicates that cost differences between the intervention and comparison groups increase over time and that the program made larger gains as it matured.[66]

In Alberta, a staged case management model for soft tissue disorders (low back, neck pain, knee, elbow, and shoulder problems) was implemented and applied consistently across the entire province.[67] In this model, authorization for rehabilitation services was made following a tiered approach that allowed up to 8 weeks of physical therapy of chiropractic care at the onset followed by a structured functional restoration intervention in a multidisciplinary team management setting for workers who had not recovered with the primary intervention. Using the model, mean disability duration decreased province-wide from 13 to 8 days compared to no change for non-soft-tissue conditions (e.g., fractures) that were not subject to the staged case management model during the same time period.

More than a third of workers off work a couple weeks after their injury who manifest low recovery expectations, indicate fear that work tasks will worsen their problem, and report radiating leg pain or multiple pain sites from an injury are still disabled a year following their injury.[39] Although specific intervention trials have not yet been conducted to test interventions for cognitive behavioral considerations in acutely injured worker populations, there is support for addressing elements of low recovery expectations and fear that activity will worsen an injury in chronic pain cases.[68] Doctors experienced in caring for injured workers frequently use office visit time to educate workers that recovery is the norm and that returning to normal activities including work helps the healing process, encourage regular incremental increases in what they do, and note that periodic discomfort and flare-ups during recovery are normal.

To summarize, the key clinical interventions a chiropractor might employ include ensuring the worker develops self-reliance to control pain (e.g., positioning, activity, directional preference training), encouraging normal activities, and providing up to several weeks of manipulation. Manipulation by itself may be best in the earliest acute stage, whereas adding exercise to manipulation appears to be more effective than manipulation alone during more subacute stages. However, if returning to normal activities including work has not occurred within 6 to 8 weeks, more aggressive integrated rehabilitation and identification of recovery barriers needs to be done.

Making sure the worker maintains their connection with the workplace and making appropriate accommodation of job tasks to fit the worker's capacity during recovery are critical to getting good outcomes, regardless of what clinical interventions are used. Setting the expectation that recovery includes returning to work and achieving functional goals along with pain relief goals is also important. Timely communication of relevant clinical information essential to making sure workers' compensation benefits are provided in a timely fashion reduces adversity, which is also associated with better long-term outcomes. The algorithm in **Figure 6-1** provides a concise summary of critical and timely issues that need to be addressed with workers' compensation patients.

WHAT DOES THE FUTURE HOLD FOR WORKERS' COMPENSATION SYSTEMS?

Musculoskeletal disorders account for the majority of occupational injuries. Noncatastrophic injuries, principally the poorly understood condition of low back pain, account for the majority of disability and health care

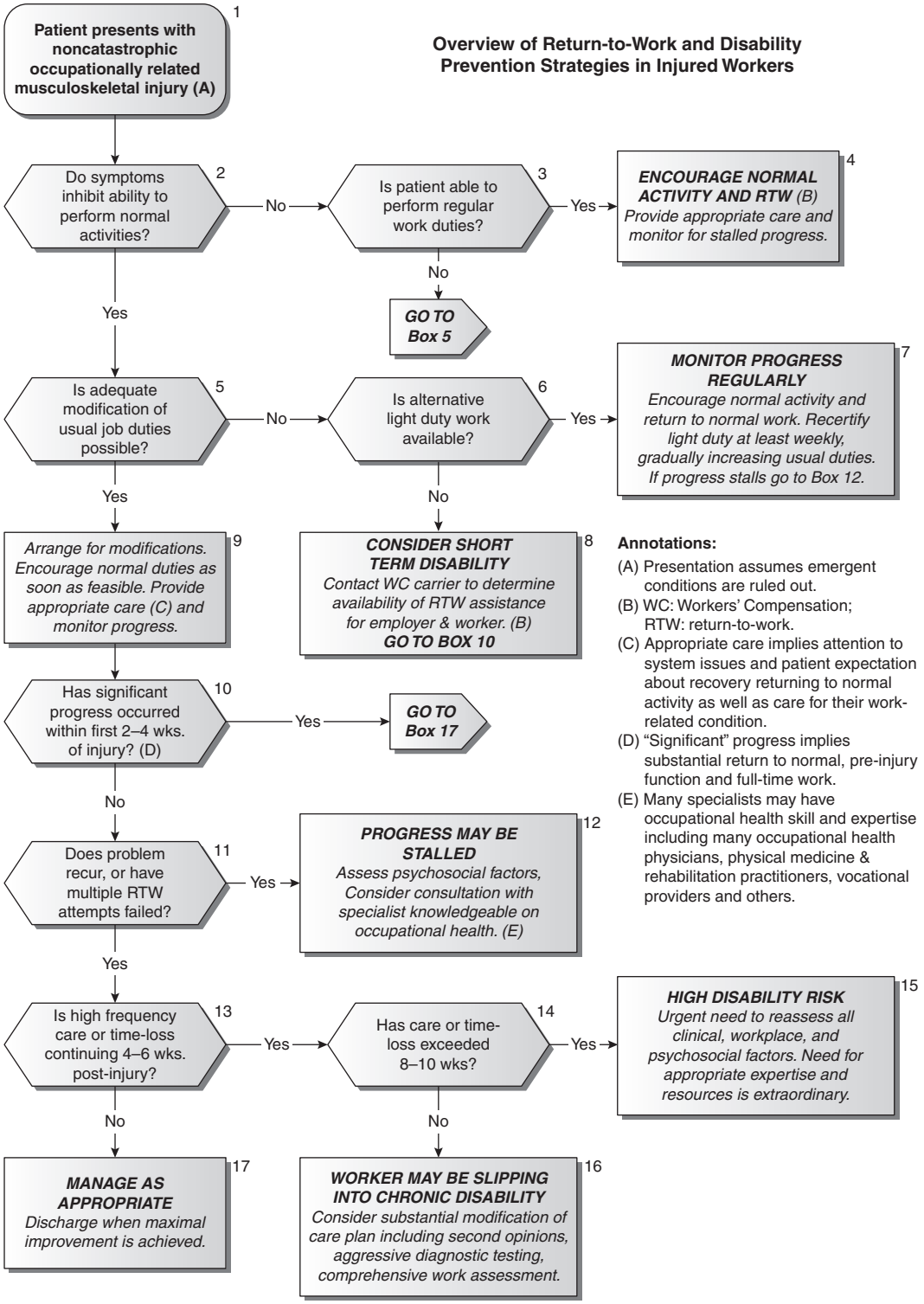

Figure 6-1 Algorithm for initial injured worker care.

Adapted from: State of Washington Department of Labor and Industries. *Attending Doctor's Return-to-Work Desk Reference*. Olympia, WA: Author, 2004. Originally from: Mootz RD, Franklin GM, Stoner WH. Strategies for preventing chronic disability in injured worders. *Top Clin Chiropr.* 1999;6(2):13–25. ©1999 Robert D. Mootz.

costs for workers' compensation in industrialized nations. Ironically, despite apparent reductions in the total number of occupational injuries, the cost of managing these patients has escalated so rapidly that total costs have risen dramatically beyond medical and consumer inflation. Other NMS disorders, especially those associated with cumulative trauma and repetitive stress, are also substantive resource users. The burden this places on the cost of doing business keeps cost containment in workers' compensation a high priority issue politically, economically, and socially.

For the most part, workers' compensation systems are turning to evidence-based decision making to inform all levels of practice and policy, sometimes wisely and with due diligence and sometimes reactively in a poorly thought-out fashion. Further, as more is understood, the old-style conventional wisdom of trying to micro-manage individual clinical care practices at an administrative level is being supplanted by better iterative outcome threshold models that establish requirements and incentives for interventions known to be beneficial if recovery and return to work are not evident within a few weeks of the onset of any care. For the practitioner, this means holding oneself accountable for more than symptomatic relief and patient satisfaction. If functional recovery (i.e., the ability to return to job duties) is not occurring with a few weeks of the onset of care, and such improvements are not sustained, greater administrative interventions and mandated second opinions are becoming the norm.

Perhaps more importantly, recent research has underscored what doctors who care for lots of injured workers have already experienced: the "artifacts" of constructive connection with the workplace, fostering expectations that returning to work is a meaningful goal of treatment, and preventing adversity from developing with the employer and administrator (systemosis) are actually critical clinical matters.

Evidence-based recommendations continue to document useful roles for conservative interventions such as manipulation and graded exercise so long as functional recovery occurs. There is not much support for exclusively using these as modalities without attention to other occupational health factors, particularly when progress slows or stalls. Caring for workers requires not only clinical expertise, but also the ability of one's practice to engage employers, assess a worker's capacity to do their job, communicate with decision makers to achieve job task accommodations when appropriate, and trigger other resources to come to bear when any barriers to these outcomes arise.

CHIROPRACTORS: AN EXPANDING OCCUPATIONAL HEALTH CARE RESOURCE

Historically, chiropractors have focused their careers primarily on service to individual patients in private or small single discipline practices. They provide relative accessibility due to broad geographic distribution. Increasingly, chiropractors have become mainstreamed and there are strategic alliances bringing chiropractic and medical services together in ways unimaginable in previous decades. Fostered by clinical need and governmental impetus, multidisciplinary research efforts have arisen in Australia, Belgium, Brazil, Canada, Italy, Japan, England, and the United States, with much better understanding of how interventions that chiropractors provide are on the radar screens of practitioners generally.[69] Multi-specialty clinics, previously a rarity for chiropractors, have grown as an important new practice style.[70] All of these trends toward integration of health care resources bode one compelling benefit: a higher quality of care with great potential for decreasing the costs associated with redundancy in the health care system. **Table 6-6** identifies several challenges faced by injured workers and shows solution strategies above and beyond chiropractors' usual direct clinical interventions that can help address them.

Occupational health is a pretty small and specialized resource in medicine. Most workers are treated by generalists, and a worker's right to choose their own doctor factors into the consideration of most workers' compensation regulation. Chiropractors are an abundant resource licensed or regulated in some 75 jurisdictions around the world,[57] and by their training approach injury care as being recoverable, have expertise in assessing mechanical onsets, and offer rational conservative intervention.

Focus groups with chiropractors in Ontario captured some of the attitudes DCs have about effective return to work.[71] Participants felt that timely return to work depended on a combination of patient characteristics, injury severity, response to care, availability of job accommodation in the workplace, and clinical judgment. These attitudes regarding concurrently addressing a broad range of factors are consistent with known occupational health best practices. The DCs also believed that a bias against chiropractic remains within the medical profession and

Table 6-6 Common Work-Related Injury Problems Chiropractors Can Become a Resource Base For

Problem	Solution Strategy
High worksite injury rate	• Consulting on worker/supervisor education of good work practices • Ergonomic on-site evaluations to support safe work habits and work environments
Inadequate modified work availability	• Conservative management of injury focused on rapid return to work before deconditioning effects can take hold • Implementing rehabilitation programs sharply focused on functional restoration and work simulation for the severely or chronically impaired • Working with insurers to identify employer resources to educate and encourage regarding accommodation, return to work, and their bottom line • Local community activism with business/labor associations and leaders to influence attitudes and availability of modified work
Multiple conflicting treatments and/or providers	• Instigating strong interdisciplinary teams tied to processes of continuous clinical quality improvement
Chronicity, treatment dependency risks	• Focusing patient education and treatment regimen on patient self-reliance, independence, and empowerment
Patient fear related to going back to work or low expectation of recovery	• Dedicating office time to identify and address specific concerns related to performing job tasks and discussing that discomfort associated with increasing activity is a normal part of recovery; if issues are persistent, exploring referral for interdisciplinary structured rehabilitation

workers' compensation boards, which establishes a significant barrier in successfully returning patients to work. As DCs embrace "systemosis" issues in addition to clinical matters, they are more likely to be considered as "go-to" resources for occupational health care.

Overall, the published experience provides a strong case for chiropractic management of work injuries. But just like other kinds of providers, regardless of the clinical tools one might prefer, knowledge and skill in addressing workplace and administrative matters need greater inclusion in the training and continuing education of DCs. Increasing chiropractors' effectiveness in these areas is fertile territory for improving the already respectable outcomes DCs are noted for.

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CHAPTER 7

CHAPTER OUTLINE

Unintentional and Intentional Injuries

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Injury has been defined as ". . . unintentional or intentional damage to the body resulting from acute exposure to thermal, mechanical, electrical, or chemical energy or from the absence of such essentials as heat or oxygen."[1] It is a global public health concern that is responsible for more than 5 million deaths each year, with approximately 180,000 of them occurring in the United States.[2,3] A significantly greater number of people sustain survivable injuries every year, with resulting pain and impairment that may remain throughout their lives. Many of these people seek chiropractic care for treatment of injury-related conditions that primarily involve the musculoskeletal system. For instance, Hurwitz et al.[4] reported that about one third of a group of 1310 chiropractic patients with low-back pain had pain related to trauma. The pain for another one third of the group was not injury-related; data were not available on the remaining one third. Thus, approximately one half of the cases where data were available were caused by injuries. Chiropractors also care for patients with injuries not related to the lower back, such as those related to sports[5,6] and automobile crashes.[7]

There are two major classifications of injury, depending on whether there is exposure to or absence of energy, as follows:

1. *Acute exposure to energy*, in which a person is exposed to kinetic energy (e.g., a fall), thermal energy (e.g., a burn), chemical energy (e.g., poisoning), electrical energy (e.g., electrocution), or radiation (e.g., radiation poisoning)
2. *Absence of essentials*, wherein a person is deprived of oxygen (e.g., strangulation) or heat (e.g., frostbite)

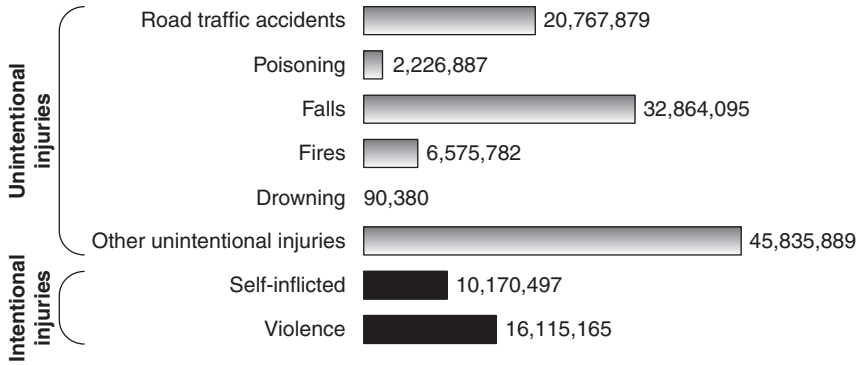

Figure 7-1 Worldwide estimated incidence of injury by cause 2002.
Source: From the World Health Organization, as reported in the World Health Report 2004.

Exposure to kinetic energy is the largest contributor to injury.[8] The underlying cause of most injuries falls into one of four categories: (1) interpersonal violence, (2) collective violence (e.g., wars and riots), (3) traffic collisions, and (4) incidents that occur at home, at work, or while engaging in recreational/sports activities.[9]

Injuries can also be classified as being unintentional or intentional, depending on the underlying cause. Injuries sustained in fires, falls, poisonings, drownings, and nearly all traffic-related injuries are examples of the *unintentional* variety. These types of injuries are sometimes incorrectly referred to as accidents. The *intentional* injuries classification is at times referred to as *violence* and is the result of deliberately inflicted harm. Intentional injuries include interpersonal violence (e.g., assault, violence against intimate partners, and sexual violence), collective violence (e.g., war), and self-directed violence (e.g., suicide). Approximately 80.5% of all injuries worldwide are due to unintentional causes, whereas 19.5% are intentional (see **Figure 7-1**). Furthermore, approximately 89% of the global injury-related years of potential life lost (YPLL) is due to unintentional causes, whereas 11% is due to intentional causes[10] (see **Figure 7-2**).

The distinction between unintentional and intentional injuries is not always clear cut, however. For example, someone taking a foolish risk, like sky-diving without an

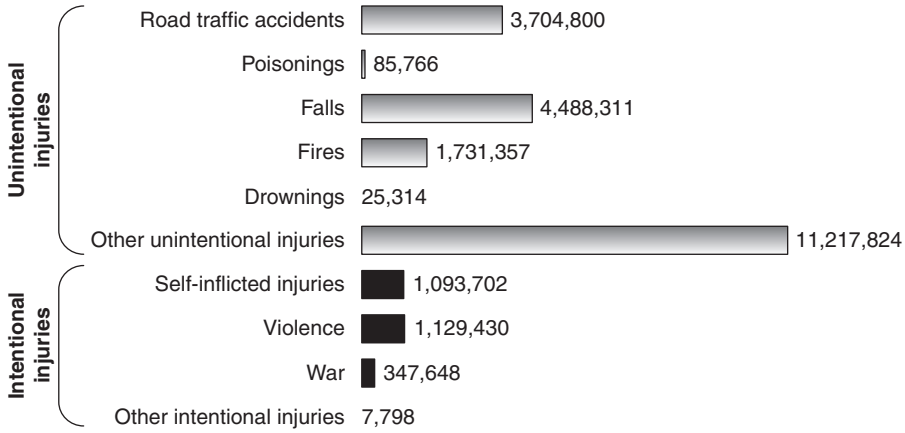

Figure 7-2 Estimated years lost due to injury-related disability, worldwide for 2002.
Source: From the World Health Organization, as reported in the World Health Report 2004.

emergency parachute, who ends up being killed or seriously injured, could be considered by some as committing an intentional act. Another example would be a suicide attempt, in which the person merely wanted to gain the attention of a loved one, that went beyond what the victim intended.

From a public health perspective, it is important to determine the causes of injuries in order to identify what activities people need to avoid or what protective actions they need to take to prevent them from occurring. Injury causation involves two aspects—an underlying cause and a direct cause. The *underlying cause* is what initiates the chain of events that brings about an injury, whereas the *direct cause* is what produces the physical damage. The underlying and direct causes may be the same or they may be different. An example where they are the same is a person who strikes his or her head on a low tree branch. In this case, the blow to the head is both the underlying and direct cause. An example in which they are different is an automobile crash victim who strikes his or her head on the windshield. In this case, the automobile crash is the underlying cause, and contact with the windshield is the direct cause. When referring to the cause of an injury, the underlying cause, rather than the direct cause, is what is most commonly of interest in public health terms.

INJURY IS A LEADING PUBLIC HEALTH CONCERN

Injuries tend to occur in younger people, who would otherwise be expected to have full life expectancies and productivity. In fact, unintentional injuries are the leading cause of death among persons 44 years of age or younger, and are the leading cause of YPLL before age 65.[2] The bar graph in **Figure 7-3** illustrates how unintentional injuries (number 3), suicide (number 5), and homicide (number 6) rank in comparison with the other 10 leading causes of YPLL before age 75. Furthermore, according to data from the *National Vital Statistics Reports'* Final Data for 2004,[11] unintentional injuries are the 5th leading cause of death in the United States, intentional self-harm is the 11th, and assault (homicide) is the 15th. (See **Table 7-1**.)

Table 7-2 provides a perspective of the impact injuries have on various age groups in the United States, based on 2004 data. Shaded cells represent deaths that were caused by injuries. Note that unintentional injury ranks number 1 in each of the age groups ranging from 1 to 44 years.

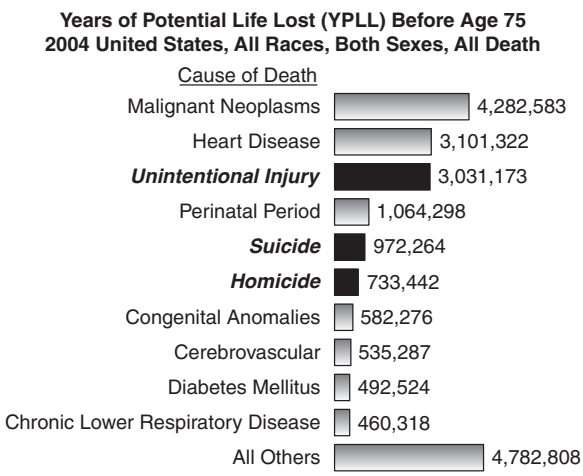

Figure 7-3 Intentional and unintentional injuries comprise 23.7% of the 20,038,295 total years of potential life lost before age 75 from all causes.

Source: National Center for Health Statistics Vital Statistics System.

The impact that injuries have on society in other industrialized countries is reasonably similar to that of the United States. In Canada, for instance, injury is the fourth leading cause of death overall, and is the leading cause of death in those who are 1 to 44 years of age.[12]

Although many deaths are caused by injury, most injured persons do not die from their injuries. Many experience a full and rapid recovery, whereas others have resulting long-term pain and disability. More than 25 million nonfatal injuries were reported in the United States in 2006,[2] and in 2000, 44.7 million people (over 16% of the U.S. population) indicated that they sought treatment for at least one injury.[13] Almost 30 million of those injured in the United States in 2004 were treated in hospital emergency departments and nearly 2 million required inpatient hospitalization.[13] **Figure 7-4** illustrates the percentages of involvement for each of the 10 leading causes of nonfatal injury in the United States in 2006. The most common cause of nonfatal injury in 2006 was unintentional fall, which accounted for 30% of the total.

The risk of injury differs between males and females, with about 54% of the 25.8 million injuries that occurred in the United States in 2006 involving males. Furthermore, the proportions of injury causes are somewhat different between males and females, as can be seen in **Figure 7-5**. The incidence rates of injuries vary depending on geographic and socioeconomic settings,

Table 7-1 Total Deaths, Percentages, and Death Rates for the 15 Leading Causes of Death in the United States in 2004

Rank	Cause of Death	Number of Deaths	Percentage of Total Deaths	Crude Death Rate*
1	Diseases of the heart	652,486	27.2	222.2
2	Malignant neoplasms	553,888	23.1	188.6
3	Cerebrovascular diseases	150,074	6.3	51.1
4	Chronic lower respiratory diseases	121,987	5.1	41.5
5	***Unintentional injuries***	**112,012**	**4.7**	**38.1**
6	Diabetes mellitus	73,138	3.1	24.9
7	Alzheimer's disease	65,965	2.8	22.5
8	Influenza and pneumonia	59,664	2.5	20.3
9	Nephritis, nephrotic syndrome, and nephrosis	42,480	1.8	14.5
10	Septicemia	33,373	1.4	11.4
11	***Intentional self-harm (suicide)***	**32,439**	**1.4**	**11.0**
12	Chronic liver disease and cirrhosis	27,013	1.1	9.2
13	Hypertension and hypertensive renal disease	23,076	1.0	7.9
14	Parkinson's disease	17,989	0.8	6.1
15	***Assault (homicide)***	**17,357**	**0.7**	**5.9**
	All other causes	414,674	17.3	141.2
	Total from all causes	2,397,615	100.0	816.5

Source: Miniño A, Heron M, Murphy S, Kochanek K. *Deaths: Final Data for 2004*. Vol. 55. Hyattsville, MD: National Center for Health Statistics; 2007.

*Death rates are on an annual basis per 100,000 population.

as well as seasonal variations. Epidemiologic methods can be utilized in the study of injury to identify and explain these variations and then develop specific interventions to target the specific groups that are involved.

THE IMPACT INJURIES HAVE ON SOCIETY

Injuries have an enormous impact on society, costing a great deal in terms of human suffering, as well as financially.[13] In addition to YPLL, the Medical Expenditure Panel Survey (MEPS) estimated that approximately $73.4 billion was spent on the treatment of injury-related conditions for the U.S. civilian noninstitutionalized population in 2002.[14] Centers for Disease Control and Prevention (CDC) estimates are even higher at $117 billion, because they combined the data derived from MEPS with data obtained from the annual National Health Accounts.[13]

However, the direct costs associated with the treatment and rehabilitation of injured persons are only part of the financial burden to society caused by injuries.

Table 7-2 Ten Leading Causes of Death by Age Group, United States, 2005, All Races, Both Sexes

Rank	Age Groups (in years)										
	< 1	1–4	5–9	10–14	15–24	25–34	35–44	45–54	55–64	65+	All Ages
1	Congenital Anomalies 5,552	Unintentional Injury 1,664	Unintentional Injury 1,072	Unintentional Injury 1,343	Unintentional Injury 15,753	Unintentional Injury 13,997	Unintentional Injury 16,919	Malignant Neoplasms 50,405	Malignant Neoplasms 99,240	Heart Disease 530,926	Heart Disease 652,091
2	Short Gestation 4,714	Congenital Anomalies 522	Malignant Neoplasms 485	Malignant Neoplasms 515	Homicide 5,466	Suicide 4,990	Malignant Neoplasms 14,566	Heart Disease 38,103	Heart Disease 65,208	Malignant Neoplasms 388,322	Malignant Neoplasms 559,312
3	SIDS 2,230	Malignant Neoplasms 377	Congenital Anomalies 196	Suicide 270	Suicide 4,212	Homicide 4,752	Heart Disease 12,688	Unintentional Injury 18,339	Chronic Low. Respiratory Disease 12,747	Cerebro-vascular 123,881	Cerebro-vascular 143,579
4	Maternal Pregnancy Comp. 1,776	Homicide 375	Homicide 121	Homicide 220	Malignant Neoplasms 1,717	Malignant Neoplasms 3,601	Suicide 6,550	Liver Disease 7,517	Diabetes Mellitus 11,301	Chronic Low. Respiratory Disease 112,716	Chronic Low. Respiratory Disease 130,933
5	Placenta Cord Membranes 1,110	Heart Disease 151	Heart Disease 106	Congenital Anomalies 200	Heart Disease 1,119	Heart Disease 3,249	HIV 4,363	Suicide 6,991	Unintentional Injury 10,853	Alzheimer's Disease 70,858	Unintentional Injury 117,809
6	Unintentional Injury 1,083	Influenza & Pneumonia 110	Cerebro-vascular 52	Heart Disease 146	Congenital Anomalies 504	HIV 1,318	Homicide 3,109	Cerebro-vascular 6,381	Cerebro-vascular 10,028	Influenza & Pneumonia 55,453	Diabetes Mellitus 75,119
7	Respiratory Distress 860	Septicemia 85	Influenza & Pneumonia 51	Chronic Low. Respiratory Disease 55	Diabetes Mellitus 202	Diabetes Mellitus 617	Liver Disease 2,688	Diabetes Mellitus 5,691	Liver Disease 7,126	Diabetes Mellitus 55,222	Alzheimer's Disease 71,599
8	Bacterial Sepsis 834	Cerebro-vascular 62	Chronic Low. Respiratory Disease 49	Influenza & Pneumonia 55	Cerebro-vascular 196	Cerebro-vascular 546	Cerebro-vascular 2,260	HIV 4,516	Suicide 4,210	Unintentional Injury 36,729	Influenza & Pneumonia 63,001
9	Neonatal Hemorrhage 665	Perinatal Period 58	Benign Neoplasms 40	Septicemia 45	Complicated Pregnancy 183	Congenital Anomalies 436	Diabetes Mellitus 2,045	Chronic Low. Respiratory Disease 3,977	Nephritis 4,141	Nephritis 36,416	Nephritis 43,901
10	Necrotizing Enterocolitis 546	Chronic Low. Respiratory Disease 56	Septicemia 36	Cerebro-vascular 43	Influenza & Pneumonia 172	Influenza & Pneumonia 354	Influenza & Pneumonia 934	Viral Hepatitis 2,314	Septicemia 3,912	Septicemia 26,243	Septicemia 34,136

Produced By: Office of Statistics and Programming, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention.
Source: National Center for Health Statistics (NCHS), National Vital Statistics System—WISQARS.

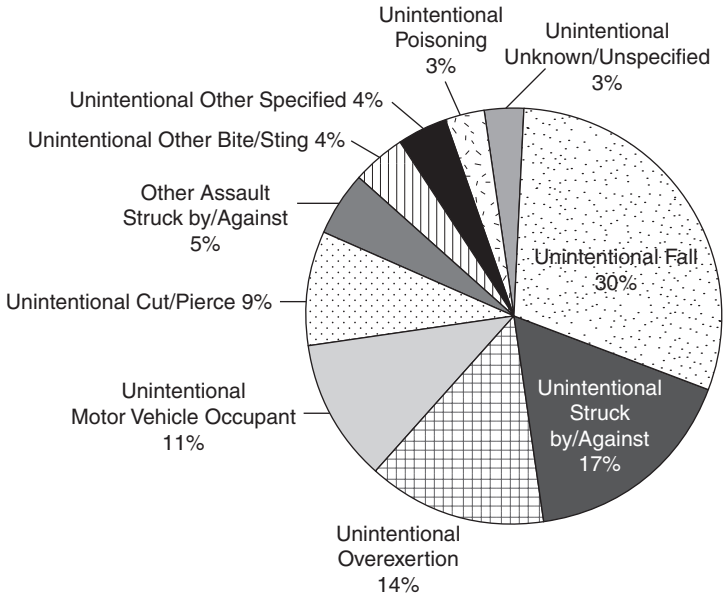

Figure 7-4 Ten leading causes of nonfatal injury in the United States for all races and both sexes in 2006; based on a total of 25,695,888 injuries.

The Other Assault category includes all assaults that are not classified as sexual assault.

Source: National Center for Health Statistics, Vital Statistics System.

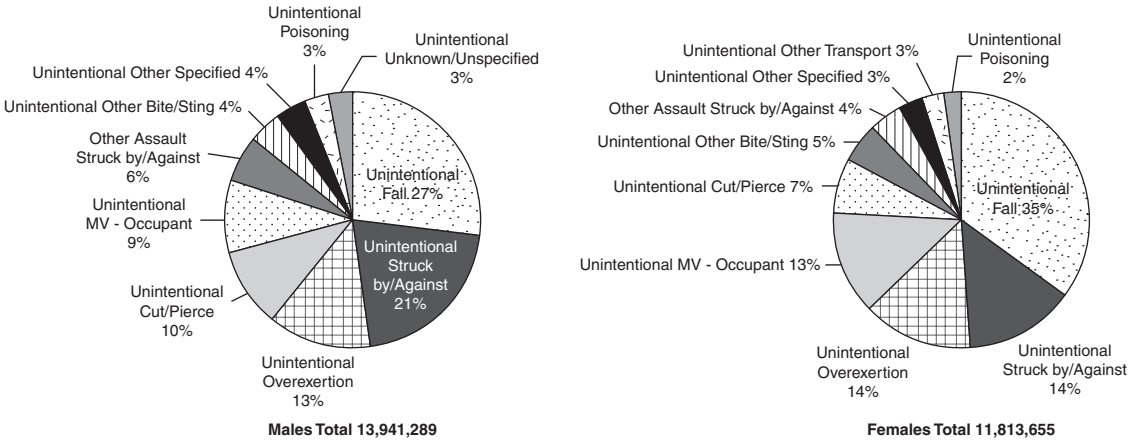

Figure 7-5 The proportions of the 10 leading causes of injury in the United States differ between males and females.

The Other Assault category includes all assaults that are not classified as sexual assault.

Source: 2006 National Center for Injury Prevention and Control. Web-based Injury Statistics Query and Reporting System (WISQARS).

Indirect costs attributable to lost earnings while injured persons are temporarily or permanently disabled, or when they die prematurely, also contribute significantly to the overall total costs.[15] Moreover, Finkelstein et al.[16] estimated that the total lifetime costs associated with injuries that were sustained in the United States in 2000 will be approximately $406 billion, with $80 billion attributable to medical care costs and another $326 billion to lost productivity. The authors also reported that about 70% of the lost productivity costs associated with these injuries was attributable to males.

Injury as a public health concern has garnered increased attention in recent years,[8] and has been labeled as "...probably the most under-recognized public health problem facing the nation today."[17] One of the national objectives of Healthy People 2010 is to reduce the rate of unintentional injury-related deaths from the 1998 baseline level of 35.0 per 100,000 population to 17.5.[1] Included in this overall objective is the reduction of the rate of deaths caused by unintentional motor-vehicle injuries from the 1998 baseline level of 15.6 per 100,000 population to 9.2.

Historically there have been great gains in injury safety through the years, with reported unintentional injury death rates falling 49% between 1912 and 2007, from 82.4 per 100,000 population to 39.8.[18] There was an overall decline in total injury mortality rates in the United States between 1979 and 1999, even though suicide rates increased in the late 1980s and homicide rates increased in the early 1990s. However, during the period between 1999 and 2004, total injury mortality rates increased 5.5%, with the most noticeable increases occurring among persons in the 20 to 29 and 45 to 54 years of age groups. Increases were noted for unintentional injuries, suicides, and injuries of undetermined intent, while homicide rates remained stable. This was the first sustained increase in injury mortality rates to be observed in the United States in 25 years.[19]

INJURIES ARE NOT ACCIDENTS

In the past, injuries were commonly regarded as accidents or random events that were for the most part unavoidable.[20] Because of this fatalistic mindset, injuries were virtually ignored by public health officials for many years and have only recently become recognized as preventable public health concerns,[21] though even now injuries are often overshadowed by other health issues that do not have nearly as much impact on health.[8]

The vast majority of injuries affect identifiable high-risk groups and are the consequence of predictable behaviors. Accordingly, the behaviors of members of these groups can in most cases be modified to reduce the likelihood of sustaining an injury or, if one does occur, to lessen its severity.[22] Modifying such behaviors leads to *injury prevention*, examples of which include the use of safety belts in automobiles and ergonomic advice in the workplace.

Chiropractors and other health care providers often provide ergonomic advice to their patients to prevent musculoskeletal injuries.[23] When injuries are not prevented, *acute care* and *rehabilitation* strategies can often reduce the odds of death or long-term disability following injury, especially when carried out quickly. *Injury control* is a term used to describe the amalgamation of prevention, acute care, and rehabilitation strategies.[24]

INJURY EPIDEMIOLOGY

A prevention model often used when studying the epidemiology of disease can be modified and applied to injury as well, in the following manner: (1) the *host* is represented by the person who is injured, (2) the *agent* by the force or energy that is involved, (3) the *vector* by the person or thing that delivers the force or energy, and (4) the *environment* by the conditions in which the injury takes place. An example of the epidemiology model applied to an injury would be an injury sustained in an automobile crash. In this case, the host is the injured person, the agent is the collision, the vector is the vehicle, and the environment is the traffic condition(s) that brought about the collision. Prevention strategies could be applied at any stage of this model in an attempt to avoid or lessen the severity of injuries in the future. For instance, in the automobile crash example, the influence of the vector could be ameliorated by improving the vehicle's crash-worthiness via crumple zones or energy-absorbing bumpers; the environment could be made better by installing a traffic signal at an unsafe intersection; and the host could play an active roll in preventing or lessening injury severity by using a safety belt.

The severity of injuries can range from mild to severe, which is sometimes referred to as the *spectrum of injury*. A mild injury may result in only temporary minor pain with perhaps partial disability, whereas a severe injury may cause intractable pain and total permanent disability, and even death. A similar sounding injury term, but having a slightly different definition, is *injury spectrum*, which refers to the mapping of an injury over time. It begins with the exposure of the host to some hazard, followed by the event, then the injury itself, and lastly the possible disability or death that may result.[9]

INJURY PREVENTION

Much of the morbidity and mortality caused by injuries can be prevented by keeping the event from occurring, by reducing the intensity of the event itself, or by providing appropriate treatment after the event has occurred. Thus, injury prevention can be targeted at three levels:

- *Primary prevention* involves preventing the injurious event from occurring or, if the event does occur, reducing the extent of the injuries; for instance, enforcing laws that prevent people from driving while under the influence of drugs or alcohol.
- *Secondary prevention* involves the prompt and appropriate management of a person's injuries. An example would be a community ensuring the adequacy of the local emergency facilities.
- *Tertiary prevention* involves improving the final outcome of a person's injuries. An example of tertiary injury prevention would be the appropriate management of an injured worker who is able to return to full employment following chiropractic care.

A tool that is frequently utilized in the public health field to develop ideas for preventing injuries is the *Haddon matrix*,[25,26] which is a table made up of four columns and three rows (see **Table 7-3**). The original matrix had only three columns, labeled the *host*, the *vehicle* or *agent*, and the *environment*. These three headings are sometimes referred to as the *injury triangle* and are derived from the injury epidemiology model described above. The third column, labeled *environment*, was later subdivided into physical and social environments. Columns in the Haddon matrix consist of factors that relate to four determinants of an injury:

1. *Host:* The person at risk of injury; for example, a person who is injured when they slip and fall to the floor.
2. *Vehicle:* The energy that is transmitted to the host through an inanimate object or another person; for example, the mechanical energy that is transmitted from the floor to a person who slips and falls to the floor.
3. *Physical environment:* The specific features of the setting wherein the injury occurred; for example, a spill that a person slips on, causing them to fall to the floor.
4. *Social environment:* The cultural and societal rules and practices in force at the time of the injury; for example, a mismanaged store that does not require employees to clean up spills promptly.

The rows relate to the phases of injury prevention:

1. *Pre-event:* Involves primary prevention before an event occurs, wherein the injury is entirely avoided; for example, a caution sign is posted to notify patrons of a spill or the spill is cleaned up before someone slips and falls to the floor.
2. *Event:* Involves secondary prevention, which attempts to protect against or diminish the extent of injury during an event; for example, a person with osteoporosis wearing hip protectors to prevent fracture in the event of a fall.

Table 7-3 Application of the Haddon Matrix in Fall Prevention at a Grocery Store

		FACTOR			
				Environment	
		Host	Vehicle	Physical	Social
				(a spill on the store's floor)	(store policies and practices)
PHASE	Pre-event	Wearing shoes with nonskid soles	"Wet floor" caution sign posted	Nonskid flooring installed	Practices in effect wherein spills are cleaned quickly
	Event	Wearing hip protectors	Cushioned flooring installed	No sharp corners or edges on nearby displays	System to recognize injured customers early
	Post-event	Acute health care and rehabilitation	Use of nonskid floor-care products	Installation of drains that prevent water accumulation	Rapid availability of emergency assistance

3. *Post-event:* Involves tertiary prevention in which treatment and rehabilitation are provided to an injured person after the event has occurred. Appropriate and timely care may reduce the seriousness of an injury and associated disability. For example, if a person sustained a serious injury to the cervical spine in a fall, proper emergency transport may prevent further injury to the spinal cord. Rehabilitation following acute care is designed to help an injured person return to a level of function as near to pre-injury as is possible.

The Haddon matrix has been a great contribution to injury prevention, but Haddon also developed 10 strategies for reducing the damage that results from the transfer of energy (injuries).[26,27] They are as follows:

1. Prevent the creation of the hazard in the first place (e.g., don't allow the manufacture of hang gliders).
2. Reduce the amount of hazard brought into being (e.g., separate heavy loads lifted by workers into lighter containers).
3. Prevent the release of the hazard that already exists (e.g., develop better brakes for cars).
4. Modify the rate or spatial distribution of the hazard's release from its source (e.g., improved ski bindings).
5. Separate, in space or time, the hazard and that which is to be protected (e.g., wider bicycle lanes).
6. Separate the hazard and that which is to be protected by interposition of a material barrier (e.g., guard rails to separate drivers from a road drop-off).
7. Modify relevant basic qualities of the hazard (e.g., eliminating, rounding, and softening corners, edges, and points on playground equipment).
8. Make what is to be protected more resistant to damage from the hazard (e.g., physical conditioning of athletes).
9. Counter the damage already done by the environmental hazard (e.g., first aid training).
10. Stabilize, repair, and rehabilitate the object of the damage (e.g., rehabilitation).

Which of these 10 strategies to choose in a given situation depends on a combination of practicality and effectiveness. For example, the first strategy is usually the most effective way to prevent injury, but it is seldom practical. If a strategy is not applicable or realistic, simply move down the list until strategies that are both effective and practical are located.

Chiropractors can and should become involved in injury prevention, primarily with their own patients, but also in their communities. Patients should be informed about basic injury risk factors, as well as how they can modify risky behaviors associated with specific activities that they participate in (e.g., wearing protective sports gear and workplace safety advice). There are also many community-wide public health injury prevention programs that chiropractors can participate in (e.g., child passenger safety and fall prevention programs). The Haddon strategies of injury prevention can be used by chiropractors and other health care providers to assist community stakeholders in their attempts to reduce the number of injuries associated with a wide variety of activities.

THE NATIONAL CENTER FOR INJURY PREVENTION AND CONTROL

The CDC, being the chief prevention agency in the United States regarding health matters, established the National Center for Injury Prevention and Control (NCIPC) in 1992 as the primary federal organization for violence prevention in this country.[28] The NCIPC's mission is to provide leadership in preventing and controlling injuries by reducing their incidence, severity, and adverse outcomes. To accomplish this, the NCIPC works with other national, state, and local health agencies and organizations, as well as research institutions.[29]

The NCIPC is composed of three divisions: (1) the Division of Acute Care, Rehabilitation Research, and Disability Prevention; (2) the Division of Unintentional Injury Prevention; and (3) the Division of Violence Prevention. Each of these divisions is organized around two teams. For instance, the Division of Unintentional Injury Prevention has the Motor Vehicle Injury Prevention Team, which focuses on drivers with medical impairments, young drivers, pedestrians, and alcohol-impaired drivers; and the Home and Leisure Injury Prevention Team, which focuses on issues like falls among the elderly, and sports and recreation injuries.

The NCIPC accomplishes its mission through research, surveillance, implementation of programs, and communications that are specific to injury. The entire NCIPC organization is based on science and the public health approach of disease prevention, which it uses to understand the causes of injuries. Then, using findings

from scientific studies, it creates injury prevention programs that effectively target these causes. Research findings are distributed to health care practitioners and other researchers, as well as other federal and state agencies.

The NCIPC website (http://www.cdc.gov/injury/index.html) is a valuable resource for chiropractors and other health care providers searching for current information on injury prevention. The website contains a wealth of information on injury prevention, including data and statistics, fact sheets on a variety of topics, and overviews of injury response strategies that are targeted to each type of injury cause.

Injury is broken into major categories by mechanism and intent. An injury mechanism can be traumatic (motor vehicle crash, gunshot wound, fall, etc.) or nontraumatic (drowning, drug overdose, etc.), and intent to cause injury can be either present or absent. Unintentional injuries by far outnumber intentional injuries, and each category is dominated by certain injury mechanisms that are related to intent. For example, firearm injuries are largely intentional, and traffic crash injuries are overwhelmingly unintentional. Likewise, there are relatively few intentional fall-related injuries or unintentional fatal knife wounds.

Unintentional Injuries

The relative frequency of different types or mechanisms of unintentional injuries differs greatly by outcome; the most common cause of fatal injuries, traffic crashes, is only the fourth most common cause of survivable injuries resulting in a visit to a hospital emergency department (see **Tables 7-4 and 7-5**). A more extreme example is poisoning; this is the second most common cause of death due to unintentional injury, yet it is not even in the top 10 causes of injury. The reason for these disparities is in large part due to the injury mechanism; some mechanisms are associated with high mortality/morbidity ratios, such as poisoning, drowning, and suffocation, whereas others, such as traffic crashes and falls, have very low ratios. These disparities result in difficulties with injury surveillance, because low mortality rate injuries that are not represented by hospital visits, such as injuries resulting from overexertion and minor falls, are often not evaluated in an emergency room setting. Indeed, many of these injuries are first evaluated in the office of a chiropractor.

In 2004 there were approximately 162,000 deaths in the United States that resulted from an injury of some kind, and more than 110,000 were associated with unintentional injuries. Traffic crashes, poisoning, and falls were the top three causes of death.

A major contributing factor in traffic crash–related deaths is alcohol intoxication. In 2006 there were 13,470 deaths associated with alcohol impairment; this accounted for approximately one third of all traffic deaths.[30] Although drugs other than alcohol are also associated with around 18% of all traffic fatalities, they are typically found in combination with alcohol.[31] Male drivers who die in traffic crashes were twice as likely to be intoxicated as female drivers, and drivers with a prior conviction for driving while impaired were eight times more likely to be among the fatalities associated with alcohol versus those who did not have a prior conviction. Alcohol impairment among drivers is an area of public health where thorough surveillance has resulted in effective prevention strategies. Impressive reductions in alcohol-related traffic deaths over the past 20 years have resulted from aggressive strategies including the use of sobriety checkpoints, revocation of the licenses of drunk drivers, community education, and required treatment for offenders.[32–35] These strategies have been particularly effective for young people; fatal crashes involving alcohol have decreased by 60% for drivers ages 16 to 17 years and 55% for drivers ages 18 to 20 years since the mid-1980s.

Age is a major risk factor for traffic crash–related death. Both new drivers (teenagers) and age-impaired older drivers are at greater risk. During 2005, 4544 teens ages 16 to 19 were involved in traffic crashes in the United States, and 400,000 teen occupants sustained nonfatal injuries that required hospital attention.[2] The risk of involvement in a traffic crash is higher among 16- to 19-year-olds than among any other age group; in comparison with older drivers, teens are four times more likely to cause a crash.[36] The teen crash fatality rate is driven by three major risk factors: gender (the fatality rate for male teens is approximately 150% that of female teens), additional teen passengers (the more passengers the higher the rate),[37] and new licensure (the highest risk is in the first year after licensure).

Older drivers are also at increased risk for traffic crash. In 2004 the CDC reported 3355 fatalities in the United States among motor vehicle occupants 65 years of age or older, and an additional 177,000 nonfatal injuries. Because of the gradual increasing age of the population of the United States, there has been a 17% increase in drivers age 65 or older between 1994 and 2004, as opposed to an increase in all drivers of only 13%, according to the National Highway Traffic Safety Administration. Increasing age among older drivers is

Table 7-4 Ten Leading Causes of Nonfatal Injury, United States, 2007, All Races, Both Sexes

	Age Groups (in years)										
Rank	< 1	1–4	5–9	10–14	15–24	25–34	35–44	45–54	55–64	65+	All Ages
1	Unintentional Fall 120,316	Unintentional Fall 828,773	Unintentional Fall 599,540	Unintentional Fall 609,893	Unintentional Struck by/ Against 1,049,015	Unintentional Fall 759,226	Unintentional Fall 777,276	Unintentional Fall 836,389	Unintentional Fall 680,772	Unintentional Fall 1,927,766	Unintentional Fall 8,035,635
2	Unintentional Struck by/ Against 32,970	Unintentional Struck by/ Against 370,572	Unintentional Struck by/ Against 399,262	Unintentional Struck by/ Against 580,236	Unintentional Fall 895,255	Unintentional Overexertion 734,805	Unintentional Overexertion 630,968	Unintentional Overexertion 491,174	Unintentional Overexertion 234,382	Unintentional Struck by/ Against 233,103	Unintentional Struck by/ Against 4,554,023
3	Unintentional Other Bite/ Sting 11,787	Unintentional Other Bite/ Sting 134,641	Unintentional Cut/Pierce 111,914	Unintentional Overexertion 284,190	Unintentional Overexertion 802,676	Unintentional Struck by/ Against 680,590	Unintentional Struck by/ Against 554,495	Unintentional Struck by/ Against 428,006	Unintentional Struck by/ Against 225,415	Unintentional Overexertion 194,557	Unintentional Overexertion 3,542,728
4	Unintentional Foreign Body 11,508	Unintentional Foreign Body 125,000	Unintentional Pedal Cyclist 95,871	Unintentional Cut/Pierce 136,935	Unintentional MV Occupant 781,653	Unintentional MV Occupant 557,034	Unintentional MV Occupant 428,068	Unintentional MV Occupant 342,784	Unintentional MV Occupant 194,267	Unintentional MV Occupant 172,408	Unintentional MV Occupant 2,655,425
5	Unintentional Fire/Burn 10,531	Unintentional Overexertion 83,099	Unintentional Other Bite/ Sting 84,977	Unintentional Pedal Cyclist 114,864	Unintentional Cut/Pierce 464,246	Unintentional Cut/Pierce 417,848	Unintentional Cut/Pierce 349,160	Unintentional Cut/Pierce 277,082	Unintentional Cut/Pierce 154,722	Unintentional Cut/Pierce 123,257	Unintentional Cut/Pierce 2,123,862
6	Unintentional Other Specified 7,980	Unintentional Cut/Pierce 82,804	Unintentional Overexertion 80,799	Unintentional Unknown/ Unspecified 100,403	Other Assault^ Struck by/ Against 450,034	Other Assault^ Struck by/ Against 284,568	Unintentional Other Specified 211,610	Unintentional Other Specified 180,887	Unintentional Other Bite/ Sting 73,587	Unintentional Other Bite/ Sting 72,138	Other Assault^ Struck by/ Against 1,232,352
7	Unintentional Inhalation/ Suffocation 6,297	Unintentional Other Specified 60,323	Unintentional MV Occupant 60,068	Other Assault^ Struck by/ Against 81,151	Unintentional Other Specified 214,132	Unintentional Other Specified 184,644	Other Assault^ Struck by/ Against 205,589	Unintentional Poisoning 139,688	Unintentional Poisoning 71,440	Unintentional Poisoning 71,576	Unintentional Other Bite/ Sting 1,044,784
8	Unintentional Unknown/ Unspecified 6,138	Unintentional Fire/Burn 51,651	Unintentional Foreign Body 53,679	Unintentional MV Occupant 77,504	Unintentional Other Bite/ Sting 188,437	Unintentional Other Bite/ Sting 157,070	Unintentional Other Bite/ Sting 142,617	Other Assault^ Struck by/ Against 127,725	Unintentional Other Specified 69,645	Unintentional Other Transport 58,146	Unintentional Other Specified 1,021,353
9	Unintentional Overexertion 6,011	Unintentional Unknown/ Unspecified 46,823	Unintentional Other Transport 45,527	Unintentional Other Transport 61,104	Unintentional Unknown/ Unspecified 165,706	Unintentional Other Transport 110,033	Unintentional Poisoning 130,115	Unintentional Other Bite/ Sting 121,272	Unintentional Other Transport 47,077	Unintentional Unknown/ Unspecified 57,153	Unintentional Unknown/ Unspecified 697,905
10	Unintentional Cut/Pierce 5,863	Unintentional Poisoning 41,737	Unintentional Unknown/ Unspecified 43,323	Unintentional Other Bite/ Sting 58,259	Unintentional Other Transport 148,813	Unintentional Foreign Body 99,353	Unintentional Other Transport 94,530	Unintentional Other Transport 76,804	Other Assault^ Struck by/ Against 40,833	Unintentional Other Specified 45,418	Unintentional Poisoning 679,890

Produced By: Office of Statistics and Programming, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention.
Source: NEISS All Injury Program operated by the Consumer Product Safety Commission (CPSC).
^The "Other Assault" category includes all assaults that are **not** classified as sexual assault. It represents the majority of assaults.

Table 7-5 Ten Leading Causes of Injury Deaths, United States, 2005, All Races, Both Sexes

	Age Groups (in years)										
Rank	< 1	1–4	5–9	10–14	15–24	25–34	35–44	45–54	55–64	65+	All Ages
1	Unintentional Suffocation 748	Unintentional Drowning 493	Unintentional MV Traffic 560	Unintentional MV Traffic 763	Unintentional MV Traffic 10,657	Unintentional MV Traffic 7,047	Unintentional Poisoning 6,729	Unintentional Poisoning 6,983	Unintentional MV Traffic 4,287	Unintentional Fall 15,802	Unintentional MV Traffic 43,667
2	Unintentional MV Traffic 140	Unintentional MV Traffic 489	Unintentional Fire/Burn 138	Suicide Suffocation 172	Homicide Firearm 4,499	Unintentional Poisoning 4,386	Unintentional MV Traffic 6,491	Unintentional MV Traffic 6,179	Suicide Firearm 2,470	Unintentional MV Traffic 7,048	Unintentional Poisoning 23,618
3	Homicide Unspecified 129	Unintentional Fire/Burn 208	Unintentional Drowning 121	Homicide Firearm 143	Unintentional Poisoning 2,484	Homicide Firearm 3,780	Suicide Firearm 2,855	Suicide Firearm 3,472	Unintentional Poisoning 2,007	Unintentional Unspecified 5,069	Unintentional Fall 19,656
4	Homicide Other Spec., classifiable 99	Homicide Unspecified 153	Unintentional Other Land Transport 47	Unintentional Drowning 132	Suicide Firearm 1,962	Suicide Firearm 2,269	Homicide Firearm 2,010	Suicide Poisoning 1,707	Unintentional Fall 1,451	Suicide Firearm 3,889	Suicide Firearm 17,002
5	Unintentional Drowning 64	Unintentional Pedestrian, Other 129	Homicide Firearm 44	Unintentional Fire/Burn 85	Suicide Suffocation 1,570	Suicide Suffocation 1,524	Suicide Suffocation 1,670	Suicide Suffocation 1,197	Suicide Poisoning 852	Unintentional Suffocation 3,271	Homicide Firearm 12,352
6	Undetermined Suffocation 50	Unintentional Suffocation 126	Unintentional Suffocation 44	Suicide Firearm 84	Unintentional Drowning 649	Suicide Poisoning 757	Suicide Poisoning 1,456	Unintentional Fall 1,181	Suicide Suffocation 575	Adverse Effects 1,708	Suicide Suffocation 7,248
7	Unintentional Fire/Burn 36	Homicide Other Spec., classifiable 74	Unintentional Pedestrian, Other 25	Unintentional Other Land Transport 63	Homicide Cut/Pierce 528	Undetermined Poisoning 564	Undetermined Poisoning 944	Homicide Firearm 1,097	Unintentional Suffocation 509	Unintentional Fire/Burn 1,178	Unintentional Unspecified 6,551
8	Undetermined Unspecified 30	Unintentional Natural/ Environment 38	Unintentional Natural/ Environment 17	Unintentional Suffocation 59	Suicide Poisoning 361	Homicide Cut/Pierce 474	Unintentional Fall 607	Undetermined Poisoning 1,026	Homicide Firearm 405	Unintentional Natural/ Environment 1,069	Unintentional Suffocation 5,900
9	Homicide Suffocation 27	Homicide Firearm 37	Unintentional Poisoning 17	Unintentional Firearm 37	Unintentional Other Land Transport 298	Unintentional Drowning 385	Unintentional Drowning 497	Unintentional Fire/Burn 506	Unintentional Fire/Burn 405	Unintentional Poisoning 931	Suicide Poisoning 5,744
10	Unintentional Unspecified 22	Unintentional Fall 34	Three Tied 15	Unintentional Poisoning 34	Undetermined Poisoning 292	Unintentional Fall 295	Homicide Cut/Pierce 426	Unintentional Drowning 492	Unintentional Natural/ Environment 376	Suicide Poisoning 603	Unintentional Drowning 3,582

Produced By: Office of Statistics and Programming, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention.
Source: NEISS All Injury Program operated by the Consumer Product Safety Commission (CPSC).
Unintentional causes are shaded.

associated with dramatically increased fatal crash rates; drivers 80 or older have the highest fatal crash death rate, with the exception of teen drivers.[38] This is in part due to the fact that older drivers who are injured in a crash are also more likely to die from their injuries, relative to younger drivers. This is despite the fact that older drivers have a higher seat belt use rate than younger drivers; 75% of older drivers and passengers involved in a fatal crash were using seat belts in comparison with only 62% for occupants 18 to 64 years old.[39]

The second most common cause of unintentional injury deaths, poisonings, are also the most easily prevented. In 2005 the CDC reported 32,691 poisoning deaths in the United States, 23,618 or 72% of which were unintentional. The CDC also reported that there were 703,702 emergency department visits associated with unintentional poisonings. There are even more cases of poisoning that do not result in hospitalization; in 2006 there were approximately 2 million reports of unintentional poisoning to poison control centers in the United States.[40] Approximately 95% of unintentional poisoning deaths were caused by legal and illegal drugs, with opioid pain medications most commonly involved, followed by cocaine and heroin.[41] The subpopulations most at risk for unintentional poisonings are men (2.1 times greater rate than women) and Native Americans, who have the highest death rate. The peak age for all unintentional poisonings is 45–49 years of age. Somewhat counter-intuitively, the lowest rate of unintentional poisonings is among children 15 or younger.[42,43]

The third most common cause of unintentional injury deaths, falls, occurs primarily among older people. Among older adults, falls are the leading cause of injury deaths and one of the most common causes of nonfatal injuries and hospital admissions.[2] More than a third of adults 65 or older fall each year in the United States, resulting in approximately 16,000 deaths, 433,000 hospital admissions, and 1.8 million visits to a hospital emergency department.[44] Falls among older adults account for the most common cause of traumatic brain injury (TBI) in this demographic, and TBI is the largest single cause of fatality associated with falls (46%).[45] The most common fractures resulting from falls are in the spine and hip.[46] According to the CDC, death occurs in elderly men 49% more often than in their female counterparts in falls, although women are 67% more likely to sustain a nonfatal fall injury. Age 65 years or older is used to categorize elderly people, though the subsection of the population 75 or older is at far greater risk for falling and dying. Nearly 85% of deaths from falls in 2004 were among people 75 or older, and those who survive are four to five times more likely to be admitted to a long-term care facility for a year or longer in comparison with younger patients.[47]

Intentional Injuries (Violence)

Although most injuries are unintentional, more than one third are related to some kind of violence. A definition of *violence* from the World Health Organization (WHO) is: "The intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, that either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment or deprivation."[48] On an average day in the United States, based on 2004 data, there are about 48 homicide-related deaths, 89 suicides, more than 1000 suicide attempts that cause reportable injuries, and nearly 5000 injuries from interpersonal assaults.[2] Consequently, violence is a significant public health problem that is dealt with not only by public health agencies, but also by a number of legal and law enforcement agencies.

Intentional injuries (homicide and suicide) affect most age groups, but are the second and third leading causes of death for persons 15 through 34 years of age[2] (see Table 7-2). The percentage of involvement for the 10 leading causes of violence-related injury in the United States in 2006 is shown in **Figure 7-6**. The most common cause was the "Other Assault, Struck by/Against" category, which made up 64% of the total. *Struck by/Against* refers to injury that is the result of being struck by or crushed by a human, animal, or inanimate object excluding a vehicle or machinery.

When considering the 10 leading causes of violence-related injuries in the United States in 2006, the total number was unequal between genders, with males accounting for 58% of the total. The proportions of causes were also different between genders, especially as regards self-harm, which was about twice as common among females, and sexual assault, which accounted for 8% of violence-related injuries in females. In fact, sexual assault was not even listed as one of the 10 leading causes in males (see **Figure 7-7**).

The Surgeon General of the United States identified violent behavior as a key public health priority in 1979, which led to an increased focus on its incidence and prevention.[49] As a result of the Surgeon General's report, the CDC actively began to investigate violence,

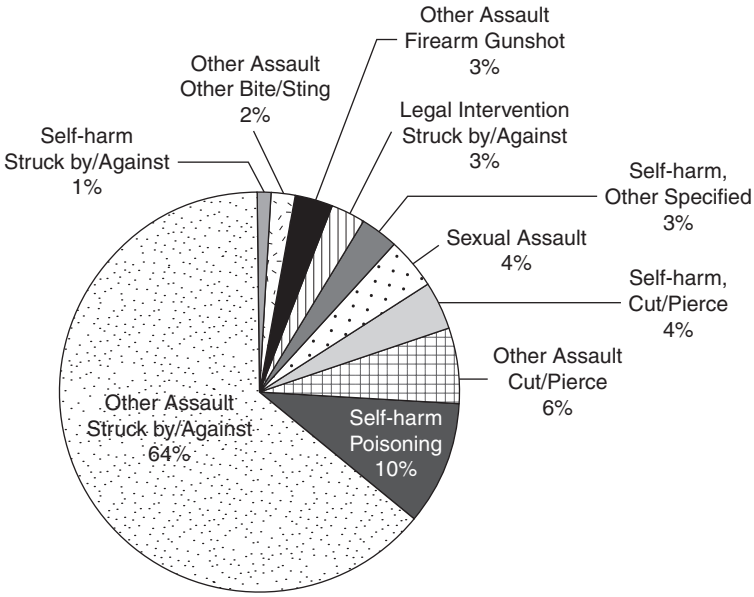

Figure 7-6 The 10 leading causes of nonfatal violence-related injury in the United States for all races and both sexes in 2006; based on a total of 2,030,272 injuries.

The Other Assault category includes all assaults that are not classified as sexual assault.

Source: National Center for Health Statistics, Vital Statistics System.

which eventually led to the formation of NCIPCs Division of Violence Prevention (DVP). The mission of the DVP is to prevent violence-related injuries and deaths using approaches that mainly involve primary prevention. Accordingly, the role of the DVP is to: (1) track the occurrence of violence-related injuries; (2) perform research into risk and protective factors for violence; (3) develop violence prevention programs and then evaluate their effectiveness; (4) assist state and community-level partners to plan, implement, and

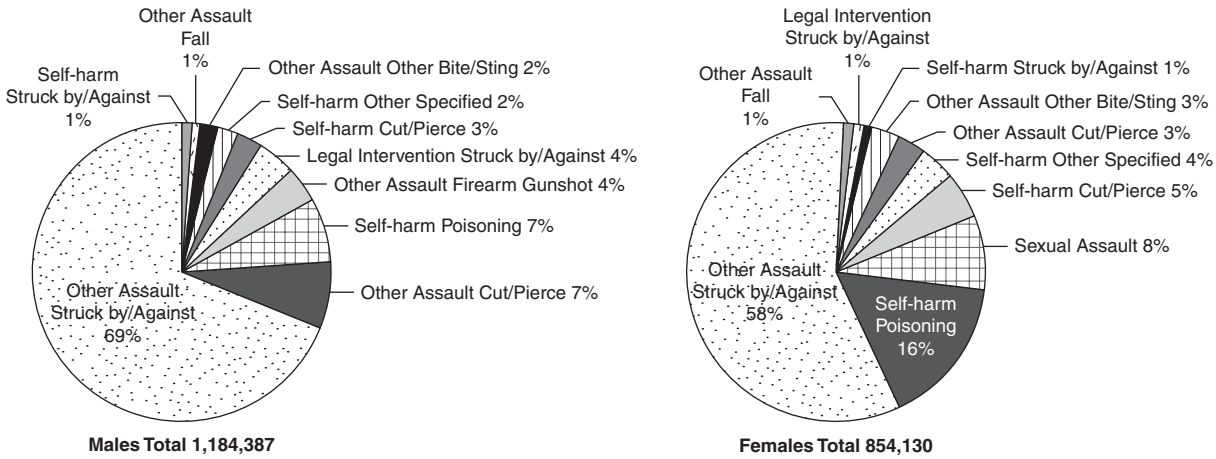

Figure 7-7 The 10 leading causes of violence-related injury for both genders.

Source: National Center for Health Statistics, Vital Statistics System.

evaluate prevention programs; and (5) carry out research to assess the effectiveness of various violence prevention strategies and determine how well they are being adopted.[50]

The DVP has two teams that deal with violence, the Youth Violence Prevention Team (YVPT) and the Family and Intimate Violence Prevention Team (FIVPT). Both of these teams use a public health approach to address the prevention of violence. The purpose of the YVPT is to conduct research and distribute information on intervention and prevention strategies designed to help prevent injuries caused by assaultive and suicidal behaviors. The FIVPT focuses primarily on violence carried out against adolescent and adult women by family members or other intimate partners.[51]

CATEGORIES OF VIOLENCE

Violence can generally be divided into three categories in relation to who commits the violent act: (1) self-directed violence, (2) interpersonal violence, and (3) collective violence. *Self-directed violence* can be subdivided into *suicidal behavior*, which involves suicidal thoughts, suicide attempts, and completed suicides, and *self-abuse*, which involves intentional harm to oneself, such as self-mutilation. *Interpersonal violence* can be subdivided into *family and intimate partner violence* (e.g., child abuse), which usually takes place in the home, and *community violence* (e.g., assault by strangers), which usually takes place outside the home. *Collective violence* can be subdivided into *social* (e.g., mob violence), *political* (e.g., war), and *economic violence* (e.g., attacks motivated by economic gain), depending on the motives for the violence.

Self-directed violence resulted in the death of approximately 32,439 persons in the United States in 2004, which represents a crude rate of about 11 completed suicides per 100,000 population. In that same year, there were approximately 425,650 suicide attempts that were reported as nonfatal injuries, a crude rate of 145 suicide attempts per 100,000 population.[2] These figures translate to about 1250 reported acts of self-directed violence per day in the United States. Only a small portion of suicide attempts are actually reported, however, because most people who attempt suicide do not seek medical attention and, if they do, they often do not report the true cause of injury to their health care professional. Unfortunately, suicidal behavior is very common among younger people, especially affecting those 10 to 44 years of age.

Suicide is a common form of self-directed violence that can be defined simply as the act of killing oneself, though it typically involves a range of behaviors that progress from just thinking about ending one's life, to planning the suicide and obtaining the means to do so (e.g., purchasing a gun), and finally to attempting and possibly completing the suicide.

A number of risk factors are commonly associated with suicide, including depression, psychiatric conditions (e.g., bipolar disorder and schizophrenia), anxiety, impulsive behavior, and a sense of hopelessness. Depression is by far the most prevalent of these risk factors, being present in up to 80% of suicides. One of the common physical manifestations of depression is pain in various parts of the body, which may prompt these patients to seek chiropractic care. Other less common physical manifestations of depression include stomach disorders, dizziness, and heart palpitations. Of all the risk factors for suicide, however, a previous suicide attempt is one of the strongest predictors of an ensuing fatal suicide.[52] *Self-mutilation* is another type of self-directed violence that can be defined as "...the direct and deliberate destruction or alteration of parts of the body without conscious suicidal intention."[52]

Intimate partner violence (IPV) refers to the threatened or actual use of physical force against an intimate partner (including sexual violence) that either causes or has the potential to cause injury or death. Psychological or emotional abuse often accompanies IPV, which may occur without actual physical or sexual violence if it was threatened or committed previously in the relationship. A variety of terms are used to describe IPV, including domestic abuse, spousal abuse, domestic violence, battering, marital rape, and date rape.[53] Intimate partners not only include legally married partners, but also common law spouses; nonmarital partners (e.g., dating partners [including the first date] and same-sex partners); divorced, former, or separated spouses (legal or common law); and former nonmarital partners.

Sexual violence involves the completed or attempted penetration of the genital opening, anus, or mouth by the penis, finger, or any other object. Sexual violence does not have to involve actual penetration, however. It also includes nonpenetrative abusive sexual contact, such as groping, and can even occur without physical contact (i.e., noncontact sexual abuse), as in voyeurism and verbal sexual harassment. Consensual sexual contact may involve the same acts that occur in sexual violence, but in sexual violence the victim does not consent to or is unable to consent to (e.g., a person with diminished mental capacity) the sexual activity.[54]

A straightforward definition from the CDC of sexual violence is "...sexual activity where consent is not obtained or freely given."[50]

Estimates of the incidence and prevalence of sexual violence vary and are prone to being unreliable because victims are often reluctant to report acts due to embarrassment or threats of retaliation. However, based on the results of a U.S. telephone survey conducted in 2001 to 2003, 1 in 59 adults reported unwanted sexual activity in the 12 months preceding the survey, and 1 in 15 (11.7 million women and 2.1 million men) had been forced to have sex during their lifetime.[55] Other reports indicate that one in five women is raped (including completed and attempted acts) during their college career.[56] In another report, the results of a U.S. survey indicated that almost 25% of women and 7.6% of men who were surveyed said they had been raped and/or physically assaulted by an intimate partner at some point in their lifetime.[57]

Child maltreatment refers to any kind of abuse and/or neglect that occurs to children who are under 18 years of age. The World Health Organization defines child maltreatment as follows: "Child abuse or maltreatment constitutes all forms of physical and/or emotional ill-treatment, sexual abuse, neglect or negligent treatment or commercial or other exploitation, resulting in actual or potential harm to the child's health, survival, development or dignity in the context of a relationship of responsibility, trust or power."[58]

Child maltreatment can be classified according to the type of abuse involved as follows: (1) *physical abuse*, wherein a child's body is injured as a result of hitting, kicking, shaking, burning, or another type of force; (2) *sexual abuse*, where a child is fondled, raped, or subjected to other sexual acts; (3) *emotional abuse*, which occurs when a child is subjected to behaviors that are harmful to the child's self-worth or emotional welfare, like name calling or threatening the child; and (4) *neglect*, where the child's parent or caregiver fails to meet their basic needs.

An accurate estimate of the frequency of child maltreatment is not available because many instances are not reported. However, the U.S. Children's Bureau, Administration on Children, Youth and Families estimated that 3 million allegations of child abuse or neglect were investigated by state and local child protective services agencies in 2004.[59] Approximately 872,000 of these investigations were determined to have actually involved child maltreatment, which resulted in the death of 1490 of the children.

Youth violence is widespread, affecting not only the perpetrators and other youth, but also their friends, families, and communities. The victims of youth violence may be harmed physically, as well as emotionally. Even those who simply witness such violent acts often suffer emotional harm. The extent of youth violence ranges from minor acts, such as bullying and hitting, to serious violent acts, such as assault, rape, and murder.

There are a number of risk factors that may lead to participation in youth violence, including fighting, bullying, carrying weapons, a dysfunctional family environment, hyperactivity, impulsiveness, having delinquent friends, prior exposure to violence, poverty, and others. Perpetrators of youth violence also tend to display other problem behaviors, such as truancy, substance abuse, and reckless driving.

According to CDC data, 5292 young persons between 10 and 24 years of age were murdered in the United States in 2004, which represents a crude incidence rate of 8.4 per 100,000 population.[2] As a result, homicide ranked as the second leading cause of death for persons in this age range in 2004. Most of these victims were male (85%) and most of them were killed by means of a firearm (81%). The problem is especially acute among African American youth, where homicide is the leading cause of death for 10- to 24-year-olds. Worldwide there were an estimated 199,000 youth homicides in 2000, according to the World Health Organization, which corresponds to an incidence rate of 9.2 per 100,000 population.[60]

Elder abuse involves the intentional or unintentional physical, psychological, sexual, or financial/material maltreatment of persons over 65 years of age that is due to acts of either commission or omission. Victims of elder abuse may have been physically assaulted and may have obvious signs of injury as a result, or they may have been emotionally or verbally abused, which may not be noticeable. The abuse may also take the form of neglect (omission), in which the victim is deprived of some physical or emotional need. The immediate family and caregivers (e.g., nursing-home personnel) are often the perpetrators of elder abuse, but social systems can also be responsible, such as when an older person is treated in a dehumanizing manner at a health clinic or pension office.[61] The 2004 Survey of State Adult Protective Services reported that the majority of perpetrators were members of the immediate family. Based on data that were collected from 11 states, 32.6% were adult children, 21.5% were other family members, and 11.3% were spouses or intimate partners.[62]

Because of underreporting and the limitations of data collection systems, the true extent of elder abuse is unknown. In fact, even less data are available about elder abuse than about intimate partner and child abuse.[8] Very little research has been conducted in this area, so there is also little information available concerning its causes or how to prevent its occurrence.[63] Nevertheless, an estimated 33,026 persons 60 years of age or older were treated in U.S. hospital emergency departments for nonfatal assault-related injuries in 2001, which represents a rate of 72 per 100,000 population.[64] Most of these persons (65%) were 60 to 69 years of age, 21% were 70 to 79 years of age, and 14% were 80 years of age or greater. Consider, however, that many of these older persons may have been injured by other forms of violence besides elder abuse (e.g., assault during a robbery). For comparison, an estimated 1,154,579 persons from 20 to 59 years of age were treated in U.S. hospital emergency departments for nonfatal assault-related injuries in that same year, a rate of 754.6 per 100,000 population.

THE PUBLIC HEALTH APPROACH TO VIOLENCE PREVENTION

Like any other health problem that affects populations, the public health approach to violence prevention is a four-step process that: (1) defines the problem, (2) identifies the associated risk and protective factors, (3) develops and tests prevention strategies, and (4) promotes widespread adoption of the effective strategies.

Defining the problem involves the evaluation of violence-related data, such as the number of reported injuries and deaths, as well as ascertaining the features of violence-related behaviors. From these data, estimates can be made on the incidence of violent acts, as well as demographic features of perpetrators and their victims.

The *identification of violence-related risk and protective factors* is derived from the analysis of data gathered in step 1 by locating factors that tend to increase or decrease the risk of becoming a victim of or a perpetrator of violence. Once risk and protective factors have been identified, this information can be used to develop violence prevention strategies that will be most effective.

Developing and testing prevention strategies follows from the previous steps and involves the actual design of the prevention programs. After they have been put into practice, programs should be evaluated at various stages of implementation to determine if they are effective at preventing violence. If not, unsatisfactory programs may need to be redesigned or redirected.

In order to *ensure widespread adoption* of new prevention programs following their successful development and testing, they must be disseminated to violence prevention organizations and agencies at federal, state, and local levels. However, the method of dissemination typically involves more than just announcements to target organizations. In order to ensure widespread adoption, program developers may need to provide assistance with training, networking, technical assistance, and process evaluation.

THE ECOLOGICAL MODEL

The ecological model (also known as the social-ecological model) has been suggested as a way of investigating the roots of violence that considers the interplay of individual, relationship, social, cultural, and environmental factors.[65] This approach is necessary because no one factor adequately explains why only certain individuals act violently or why some communities are more prone to violence than others. Thus, familiarity with the ecological model for understanding violence is important for those who intend to use the public health approach in violence prevention (see **Figure 7-8**).

The first level of the ecological model concerns the individual; biological and personal history factors that might influence an individual's behavior are examined. The specific purpose of this inquiry is to identify characteristics of the individual that might increase their chances of becoming a victim or a perpetrator of violence. Examples of factors that are relevant to this type of investigation include low educational attainment, substance abuse, and a prior history of aggression.

The second level of the ecological model has to do with the ways in which close relationships can increase the chances of a person becoming a victim or a perpetrator of violence. Close relationships include peers, intimate partners, and family members. An example of a relationship factor is a young person who becomes involved in violence because the associated behaviors are encouraged and approved by his or her friends. Another example is an intimate partner who shares a home with an abusive person and is exposed to ongoing violent encounters.

The third level of the ecological model involves the community in which close relationships are established. Communities may include schools, neighborhoods, clubs, churches, and others. Characteristics of the community that may increase the likelihood of becoming victims or perpetrators of violence are identified in this level of investigation. Highly populated areas, areas of

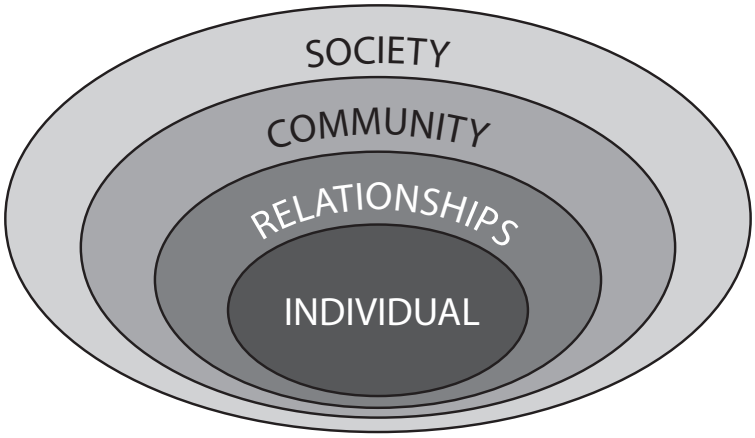

Figure 7-8 Diagram of the ecological model for understanding violence.

Source: Dahlberg L, Krug E. Violence—a global public health problem. In: Krug E, Dahlberg L, Mercy J, Zwi A, Lozano R, eds. *World Report on Violence and Health*. Geneva: World Health Organization; 2002:12.

poverty, and areas where social isolation is common are examples of community characteristics that have been reported to be associated with violence.

The fourth level of the ecological model considers society in general regarding its influence on violence. Some examples of societal factors include cultures that encourage violence as a suitable way to resolve conflicts, cultures that support male dominance over women, and cultures that value parental rights over the welfare of children.

It is common for multiple risk factors to work in synchrony leading up to a particular act of violence. For example, poverty, substance abuse, and access to firearms are risk factors for more than one type of violence (e.g., suicide, murder, and assault). It is also common for individuals who are at risk of violence to be exposed to more than one type of violence. For example, an intoxicated female on a first date is at risk of sexual violence by her intimate partner and is also at risk of physical violence.

VIOLENCE PREVENTION IN THE CHIROPRACTIC OFFICE

Chiropractors commonly provide care to injured persons, some of whom are no doubt victims of violence. Unfortunately, many patients do not provide a reliable history in cases of violence because of embarrassment or not wanting to get the perpetrator involved. Chiropractors should therefore observe their patients' behaviors, especially those with injuries, for the presence of risk factors that may lead to violence to self or others. Whether the patient is a victim or a perpetrator, the practitioner may be compelled to take some kind of action. Patients presenting signs of possible physical abuse may be reportable to law enforcement agencies. The presence of certain risk factors, such as patients showing suicidal behaviors and apparent victims of abuse, will in many cases require prompt referral to an appropriate professional or agency.

Because referrals of this nature will undoubtedly be necessary in the typical chiropractic setting from time to time, a referral resource list should be created and maintained. The list should minimally contain contact information for mental health agencies and professionals, as well as the police department. Moreover, there are a host of local, state, and national resources available to assist both patients and practitioners who seek answers to specific injury-related questions. The NCIPC maintains a list of injury-related websites that provide information on a variety of topics (http://www.cdc.gov/ncipc/injweb/websites.htm).

Chiropractors are required by law to report certain violence-related injuries (e.g., self-inflicted and assault-related). For instance, all 50 states have mandatory child abuse and neglect reporting laws, and many states have wide-ranging statutes that require "any person" to report such abuse. Suspected child abuse should be reported to a local law enforcement or child protective services agency. Most states require a verbal report be made to one of these agencies immediately or within 24 hours, followed by a written report.[66] Mandated reporting laws differ from state to state, so the reader is advised to become acquainted with the laws that apply to their local jurisdiction.

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CHAPTER
8

Infectious Disease

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CHAPTER OUTLINE

INTRODUCTION

HIV/AIDS, Lyme disease, *E. coli* O157, hepatitis C, and severe acute respiratory syndrome (SARS) all have one thing in common: they, and many other diseases, were discovered to be public health threats within the last 30 years.[1–3] In about that same time frame, smallpox was eliminated,[4] polio and guinea worm were nearly eliminated,[5,6] a vaccine was developed for some infectious causes of cervical cancer,[7] and antibiotic resistance has become a real challenge.[8–10] In addition, tuberculosis has become resistant (and XDR—extensively drug resistant) to antibiotics, as have malaria and gonorrhea.[2,11–13] *Pandemic* influenza has been recognized as a real and imminent threat (with three pandemics in the previous century killing an estimated 40–50 million people).[14,15] Preventable sexually transmitted infections continue to occur with alarming frequency, with 40% of sexually active teenage girls in the United States having a sexually transmitted disease,[16] and 340 million new cases of curable sexually transmitted diseases occurring every year around the world.[17] Anthrax has been used in bioterrorist acts against the United States[18] and bioterrorism remains a real concern. These are real, varied, and pressing issues surrounding public health and infectious disease.

As health care providers, chiropractors can play an important public health role as advocates for their patients and their communities with policy makers and with health care and public health professionals regarding infectious disease. Chiropractors can participate in the public health policy discussion surrounding these critical issues. This chapter will provide some fundamental background to help chiropractors fill these roles. Therefore, it is important to note that this chapter will not take an encyclopedic approach to individual infectious diseases. This chapter is about concepts (with examples) that will permit chiropractors to enter the conversation about infectious disease and bring their specific skills to the public health table. This chapter should serve as a broad and useful introduction to infectious disease public health principles for chiropractors.

PATTERNS OF DISEASE DISTRIBUTION

Although diseases occur in individuals, it is the pattern of distribution of health and disease in individuals that becomes apparent at the community or population level. Whereas clinicians are interested in recognizing and treating diseases within individuals that present in offices one patient at a time, public health practitioners are interested in indentifying population-level risk factors and understanding the distribution of those risk factors, as well as the distribution and impact of disease in populations.

Human diseases generally do not appear randomly distributed around the globe or even within communities. Instead, there are characteristic patterns of distribution related to organism characteristics, environmental and natural factors, human biology and behavior (at an individual, community, and population level), and other related factors. Lyme disease, for example, is more prevalent in areas where humans are in closer contact with wooded areas in certain regions of the country and in individuals who are outside in those areas without appropriate insect repellants.[19] Tuberculosis is on the rise in many areas, in part because of the continued spread of HIV,[20] and antimicrobial-resistant tuberculosis is on the rise in part because of the lack of public health infrastructure in many areas of the world to ensure the months-long course of treatment is completely followed.[13] Human behavior, disease characteristics, and organism factors are among the items that combine to produce patterns of distribution. In this section, terms that permit description of the distribution, measure, and burden of disease will be defined and described.

Measures of Distribution

How many new cases of a disease occurred in a population last year? How many people in a community have the disease or have ever had the disease? How severe are the diseases—and are the diseases equally severe in different populations? The terms defined in this section cover many of the essential determining and defining characteristics of distribution of disease in populations.

Incidence

Incidence is a description of the number of new cases of a disease that occur in a given time period. This term refers only to new cases; if 50 people in a community already have a given disease when the measuring of incidence begins, only new cases that occur in the new time period of interest count, not the original 50. Some infectious diseases will have very low incidence, such as rabies in humans, which leads to only two to three deaths per year in the United States.[21] Others will have an incidence in the hundreds of millions annually, such as malaria in sub-Saharan Africa, where 200–300 million clinical cases occur per year.[22] In areas where malaria is *endemic*, individuals can be reinfected multiple times by the *Anopheles* mosquito.[23] The incidence can be

described as an *incidence rate* if the number of new cases that occur in a time period is defined per population size. For example, in the United States, the 2002 incidence rate of pertussis was 3.01/100,000.[24] In public health, the purpose of primary prevention is to reduce the incidence of a disease or condition.[25]

Prevalence

Prevalence refers to the number of cases that exist at a given time. If 50 people in a population already have a given disease and 3 new cases have developed within the time frame being assessed or by the point in time of assessment, there would be a prevalence of 53 cases. The "point" in time can literally be a moment in time, or it can cover a year or other time period. The prevalence may be higher or lower than the incidence, depending on how often people are reinfected, how long the disease lasts, and how long people survive with the disease. HIV/AIDS initially had a high incidence and low prevalence, because early detected cases had a high mortality rate. However, at least in developed nations, the prevalence of HIV/AIDS is increasing as survival is increasing.[26] The prevalence of HIV/AIDS in the United States in 2003 was about 1 million.[27] Annual incidence of new HIV infections is about 40,000 in the United States.[28] In public health, the purpose of secondary prevention is to reduce the prevalence of a disease or condition.[25]

Attack Rate

The primary *attack rate* is the proportion of the exposed population to develop infection (the primary infection). If 25% of a given population that was exposed to a given organism developed infection, the primary attack rate would be 25%. The secondary attack rate reflects the proportion of individuals exposed to others with infection who then went on to develop infection themselves; it reflects *infectivity*.[25,29] During the SARS outbreak in Ontario, Canada, in 2003, the household secondary attack rate was 10.2%[30]; that is, 10.2% of household contacts of individuals with primary infection developed infection themselves within the incubation period before the outbreak was controlled.

Relative Risk

The *relative risk* is the ratio of the incidence of the disease or condition in the exposed population to the same incidence in the unexposed population. With infectious disease, the relative risk of contracting the disease will be higher with exposure to the disease; however, "exposure" can refer to risk factors, to mediating factors, or to the disease organism, depending on context. Therefore, the relative risk of disease in an exposed group could actually be lower than in the unexposed group if the exposure under consideration is immunization.[31] For example, the infection rate for *Haemophilus influenzae* type b among Amish children under 5 years of age (less likely to be immunized) in Pennsylvania was found to be 88 times greater than the general under 5 years population in Pennsylvania (more likely to be immunized).[32] The relative risk of contracting *Haemophilus influenzae* type b with exposure to immunization is therefore much lower than the risk of contracting the disease without the exposure to immunization.[33] With relative risk, a value of 1.0 would indicate no difference in risk of disease or outcome based on exposure status.

Morbidity and Mortality

Morbidity is anything less than full well-being. *Comorbidity* is a term frequently used to describe the other diseases or health burdens a patient is experiencing in addition to the disease or condition in question. In public health, tertiary prevention is the reduction of morbidity associated with the disease or condition in question.[25] Mortality can be used generically as a measure of fatality, or can be more specifically associated as a measure of the impact of the disease or condition in question.

Factors Impacting Distribution

The terms discussed thus far permit a description of the burden of disease (in terms of incidence, attack rate, relative risk, and mortality, for example). These qualities, as well as the distribution of disease, are affected by other factors: how the disease is transmitted and what the *reservoir* of the causative agent is. An infectious agent that only has a human reservoir—such as smallpox, polio, or guinea worm—might be eliminated (complete reduction of incidence and prevalence) if appropriate and exhaustive control measures are in place (given other features as well).[34] Other critical factors in the distribution of disease include the infectivity, *pathogenicity*, and *virulence* of the causative organism. These and other factors that impact the distribution of disease will be discussed here.[25,35,36]

Method of Transmission

The major methods of transmission of infectious agents include transmission via direct or indirect contact; by air,

food, or water; or by a *vector* (such as an infected insect). Transmission during pregnancy or delivery is referred to as *perinatal* transmission. This section will outline some key infectious agents as examples of each form of transmission. The examples of infectious disease organisms listed in the following sections serve to illustrate the methods of transmission, not to be exhaustive either of the ways those organisms can be transmitted or of all the organisms transmitted through these means.

Contact

Direct contact includes sexual contact or skin contact, whereas indirect contact includes contact with contaminated items (such as chiropractic tables) that might be contaminated with infectious droplets, blood, or other bodily fluids.[37,38] Humans and animals are considered *infected* when they carry infectious organisms (and can be either symptomatic or asymptomatic). The infecting dose is the *inoculum*. Inanimate objects are *contaminated* when they have infectious agents on their surfaces. Those contaminated inanimate objects that transfer infectious agents to humans are termed *fomites*.

A classic disease spread by sexual contact is syphilis, which produces a painless chancre at the site of transmission of *Treponema pallidum*.[39] The global burden of syphilis (and other common curable sexually transmitted infections such as gonorrhea and chlamydia) includes an annual incidence of 340 million new infections.[17]

HIV, which is spread by sexual contact as well as by other contact (including contaminated fomites that successfully break the skin, such as with a needle-stick injury) and perinatally, is associated with as many as 6.3 million new infections globally in 2003, with 38.6 million people estimated to be living with HIV.[40] It is perhaps the most important emerging infectious disease of the last century.[41]

An organism of interest spread by multiple routes including skin contact and fomites is methicillin-resistant *Staphylococcus aureus* (MRSA), which causes both community-associated (CA-MRSA) and health care–associated (HA-MRSA) infection.[42–44] The 2005 incidence rate of invasive MRSA in the United States was 31.8 per 100,000.[9]

Air

Infection by air occurs with agents such as the influenza virus or tuberculosis bacterium, transmitted by airborne droplets of varying size.[45–48] Additionally, relatively new infectious diseases such as SARS and Legionnaires' disease spread by air.[1,49] Anthrax (which can spread by air) has been used as a bioterrorist weapon.[18] These five infectious agents will be discussed here.

Influenza is one of the more important respiratory diseases, and will receive separate attention later in this chapter, when influenza A/pandemic influenza is discussed as a way to bring together all of the concepts of this chapter. Pneumonia has been one of the largest causes of morbidity and mortality, and is often the listed cause of death in influenza infection, because it is a secondary or comorbid infection with influenza.[48,50,51]

Tuberculosis (*Mycobacterium tuberculosis*) will also continue to receive more attention in this chapter when the breakdown of public health infrastructure and antimicrobial resistance are discussed. Nevertheless, tuberculosis was formerly one of the most important causes of mortality in the United States, and is one of the two most important sources of mortality in adults around the globe, the other being HIV/AIDS.[52] The disease is resurgent globally, in part because of comorbid HIV infection.[20] Multi-drug-resistant (MDR) and extensively drug-resistant (XDR) strains have developed for many reasons, including occurrence of the disease in areas without sufficient public health infrastructure to provide the needed observed therapy over extended periods.[47,53,54]

SARS was transmitted by a coronavirus: SARS-CoV.[1,55] SARS spread from the original index case to others who stayed in the same hotel and hospital, and to health care workers and others who entered the same room as these patients.[56] SARS eventually infected over 8000 people in over two dozen countries, killing nearly 800.[1] The global public health response helped to contain the threat, and on July 5, 2003, the World Health Organization (WHO) declared that all chains of communication had been broken globally and the epidemic had been contained.[57] However, it is anticipated that future outbreaks will likely occur, and the WHO declares this to be an interepidemic period for SARS.[55]

Legionnaires' disease—a form of pneumonia caused by *Legionella pneumophila*—was first detected in a hotel in Philadelphia where many members of the American Legion were staying for a convention. Those who became ill appear to have inhaled aerosolized droplets suspended in the ventilated air from the hotel cooling tower. There are currently about 8000–18,000 hospitalizations per year for this disease in the United States, though many more infections go undiagnosed.[49]

Anthrax was used as a bioweapon in 2001 against the United States through deliberate transmission of *Bacillus anthracis* spores through the U. S. postal system.

The attack resulted in 22 people having anthrax infection. Half of those with inhalation anthrax from airborne spores died of their infections.[18] As tragic as this was, it has been estimated that a larger deliberate release of anthrax spores in an urban area with up to 100,000 exposed could produce infection in 50,000 people, with 32,000 deaths and a cost to contain the outbreak of at least $26 billion per 100,000 exposed, or $200 million per hour to contain.[58]

Food or Water

Ingestion of contaminated food or water can produce serious infection. Food and water can contain the infectious agent itself (such as the parasite *Giardia intestinalis*, the noroviruses, the bacteria *Vibrio cholera* and *Campylobacter jejuni*, the hepatitis A virus, the prion cause of variant Creutzfeldt-Jakob disease [vCJD], or *Escherichia coli* bacteria, including *E. coli* O157). The infectious agent may be in hardy cyst or spore form, as with the *Cryptosporidium parvum* parasite (spread by oocyst) or the bacteria *Bacillus anthracis* or *Clostridium perfringens* (both spread by bacterial spore). Additionally, the food or water can contain the toxin produced by the agent (such as *Staphylococcus aureus* or *Clostridium botulinum*) or other toxins (such as aflaxtoxin).[59–62] As many as 76 million Americans are foodpoisoned each year, with 325,000 hospitalizations and 5000 deaths.[63] Although most cases of foodborne illness in North America occur as sporadic cases of food poisoning, a cryptosporidium outbreak in Milwaukee in 1993 sickened 403,000 people with a total cost of illness of $96.2 million.[64] Worldwide, 1.8 million people die of diarrheal illness annually, most of which is believed to be related to food- or waterborne illness.[62] Hand washing with uncontaminated water, sanitation, and hygiene are critical in the control of these diseases globally—but so are monitoring antibiotic resistance in livestock routinely provided antibiotics in feed[65] and keeping ruminants out of the food chain of other ruminants.[62]

Bioterrorist agents can be spread by food or water. As already noted, anthrax has been used as a bioterrorism weapon against the United States, and anthrax can produce gastrointestinal disease if consumed. The U.S. food system is vulnerable to the deliberate introduction of botulism toxin. Just 10 grams of botulism toxin could kill a half million people within 6 days through introduction in the milk supply. Other types of food are similarly vulnerable.[66] Therefore, although food- and waterborne illnesses remain a staggering and ongoing source of disease worldwide (which demand the best of control efforts to improve hygiene and sanitation globally), public health authorities also must continue to develop tools to prevent, detect, and control outbreaks, including those associated with bioterrorism.[2,67] More information on this topic is supplied later in this chapter in the discussion of surveillance.

Vector

Vector-borne disease is among the most significant sources of morbidity and mortality from all infectious diseases globally and historically. Vectors are organisms (animals and insects, for example) that transmit disease to other organisms without causing the disease themselves. For example, the *Anopheles* mosquito transmits to humans the *Plasmodium* parasites that cause malaria—up to 500 million cases per year, with 1 million deaths.[23,68] The plague (infection with *Yersinia pestis*) wiped out one about half of Europe's population in the 14th century (with other similar devastating outbreaks in other regions). *Yersinia pestis* was spread by fleas (often *Xenopsylla cheopis*) that had blood meals of infected rats, became unable to digest the blood meal, and then bit humans in a desperate search for nourishment.[69–71] There continue to be sporadic plague infections in the United States, and outbreaks in many regions of the world.[69,71] Diseases spread by insects are said to be arthropod-borne, and a class of viruses specifically spread in this manner are termed arboviruses. Other examples of vector-borne disease, including other arthropod-borne diseases, are Lyme disease, West Nile virus, rabies, Eastern equine encephalitis, Chagas disease, and yellow fever.[21,72,73]

Perinatal

Perinatal transmission is the transmission of infectious disease from mother to child. This transmission can occur *in utero* (transmission across the placenta), or through exposure in the birthing process or through breast milk. Infectious agents that cross the placenta can be remembered with the TORCHS acronym: Toxoplasmosis, Other (HIV, varicella zoster, and parovirus B19), Rubella, Cytomegalovirus, Herpes simplex, and Syphilis.[26,74] Infectious agents that can cause disease through exposure during birth include any contact and bloodborne pathogens, including sexually transmitted diseases in the mother (such as gonorrhea, genital herpes, and chlamydia).[75] HIV can be transmitted across the placenta, during birth, and through breast

milk. Highlighting the role of public health, perinatal transmission of HIV in the United States has declined from 1650 cases in 1991 to around 175 in 2002, with the decline attributed to a variety of interventions.[76]

Reservoir

Reservoirs are the hosts or locations where infectious organisms live or multiply that permit them to infect other organisms. There are four basic categories of reservoirs: humans (infections of humans are *anthroponoses*), other biologic species (organisms that infect or involve plants or animals are referred to as *zoonoses*), soil, and water. As noted in the introduction to this chapter, smallpox has been eliminated. This was possible in part because smallpox had two essential characteristics: only human reservoirs and *immunogenicity* (which is discussed a little later in the chapter). Because of this and other contributing factors, it was possible to comprehensively vaccinate against and eventually eradicate the disease; smallpox no longer exists in nature and was declared eradicated in 1977.[4] Other organisms have nonhuman reservoirs or multiple reservoirs. Eradicating them is impossible or practically so, though control becomes important (as discussed below).[34]

Incubation Period and Period of Communicability

The *incubation period* refers to the amount of time between exposure to an infectious agent and when the host shows symptoms of disease or infection that can be confirmed by laboratory diagnosis. Incubation periods can vary greatly, from hours to days or years. The incubation period must be distinguished from the *period of communicability*, which is that window of time in which the infected host is capable of infecting others. The incubation period and period of communicability can overlap, as in hepatitis C and HIV/AIDS.[77,78] Some people transmit infectious agents without ever being classically symptomatic—these persons with *inapparent infection* who transmit infection are known as carriers, and will be described later.[79]

Susceptibility

Immune status plays a significant role in determining whether an individual is susceptible to a disease given exposure to the infectious agent. Susceptibility can be affected by immunosuppression, nutrition status, age, immunization (which will be discussed in further detail later), and other risk factors.

Certain infections and medications can have an immunosuppressive effect and increase susceptibility to other infections. Infection with measles (*Morbillivirus*) produces a substantial immune suppression, opening the host to infection with other agents.[80] HIV works by suppression of CD4+ T lymphocytes, leading to an inability to ward off infection and the hallmark infection with opportunistic agents.[78] Other sexually transmitted infections can greatly increase the rate of HIV transmission, and may in fact be responsible for up to 40% of HIV transmission.[17] Immunosuppressive drugs can also increase susceptibility to opportunistic agents. Cryptosporidium can cause persistent diarrhea in the immunocompromised and gastrointestinal illness and diarrhea in healthier individuals. The cysts may be present in many community water systems, which do not always effectively remove or neutralize them.[81]

Nutritional status plays a role in susceptibility. With measles infection, vitamin A deficiency may lead to additional mortality. The World Health Organization recommends vitamin A supplementation for children during measles infection, though this regimen may be helpful to only some children under 2 years of age.[82] The WHO reports a 23% reduction in all-cause mortality in children under 5 years of age with vitamin A supplementation in regions of the world prone to deficiency.[83]

Age plays a factor in susceptibility, because the elderly and the very young typically bear much of the burden of infectious diseases. Influenza and pneumonia tend to especially impact the elderly (with the exception of pandemic influenza, which can strike healthy young adults, for reasons to be discussed later).[15,48] *Haemophilus influenzae* type b tends to strike the very young, causing meningitis in unvaccinated populations.[33,79,84] A host of sexually transmitted diseases are more common among 15- to 49-year-olds.[17]

Illicit drug use is a risk factor for infectious disease, in part because risky behaviors (such as drug use and risky sexual behavior) often occur together. HIV and syphilis have been associated with cocaine usage; the risks appear to be increased with exchange of sex for money or drugs.[85,86] However, certain drugs themselves can alter biology in such a way as to increase the risk of infection synergistically. Drugs such as methamphetamines may make protective surfaces (including the vagina and anus) more prone to bleeding (through both method of use and biologic action) and therefore more prone to fail to inhibit transmission of infectious organisms.[87]

Aggregate/Population Behaviors

If a broken public health infrastructure leads to an increase in XDR tuberculosis,[13,54,88] or if risky sexual behaviors in the marginalized and antibiotic usage lead to resistance in gonorrhea or epidemics of syphilis,[11,85,86] or if curable sexually transmitted diseases facilitate transmission of incurable sexually transmitted diseases like HIV,[17] or if industrial-scale poultry farms bring millions of birds and humans into contact to facilitate transfer to humans of novel strains of influenza,[89] it is clear that each of us must have an interest in the health of all of us, because infectious diseases do not recognize national borders, and larger social factors influence individual decisions, risks, and environments.[90] A few examples of larger social factors will be considered here as ways in which the behaviors of communities and populations influence the health of individuals.

Poverty and Socioeconomic Factors

Individual behaviors and conditions are greatly impacted by factors outside their sphere of influence. Around the globe, one third of the population is infected with tuberculosis, with over 1.5 million deaths per year.[91] Hundreds of millions of clinical cases of malaria occur per year.[22] Fifty million people are infected with dengue fever per year.[92] Millions die of diarrheal diseases every year.[93] Over 6 million people per year are infected with HIV and nearly 40 million are living with infection.[40] These are not necessarily the top headlines in the relatively well-off Western world, where relatively few die of these diseases. Yet in some areas of the world, infectious diseases such as these cause enormous morbidity and mortality. Ten percent of the world's population (the residents of sub-Saharan Africa) experience 60% of the global deaths from infectious disease.[94]

Poverty and infectious disease reinforce each other across the globe—and the map of global poverty and the map of infectious disease burden resemble each other quite closely.[94] Social structures reinforce epidemic disease among the poor and isolate the poor. Any solution for infectious disease challenges cannot neglect the social changes needed to break down these barriers.[41]

War and Social Upheaval

War results in social upheaval and the breakdown of systems and patterns that support health. The most famous example of this is the global influenza pandemic in 1918–1919 that killed as many as 50 million people. It is felt that World War I created conditions that may have allowed the pandemic to occur.[15,95] The pandemic certainly may have contributed to the end of World War I, having a predilection for young adults as it did.[15]

Of great ongoing concern is disease in refugees of war who frequently lack access to sanitation and medical care, and who are often concentrated in camps where disease can easily spread. In 2006, the number of refugees globally stood at 9.9 million and the number of internally displaced persons stood at 12.8 million.[96] Causes of death among refugees include diarrheal illness (such as cholera and shigellosis), acute respiratory infections, measles, malaria, and other diseases.[97]

Urbanization is another example of social upheaval. About 50% of the global population now lives in urban areas, and this number is expected to rapidly expand to 66% by 2030. The urban poor experience a higher incidence of infectious disease than the rural poor. Public health infrastructure, which might have met the needs of the better off, fails in meeting the needs of the expanding numbers of urbanizing poor. Globally, 50–70% of those in urban areas live in extreme poverty, many without any access to clean water or sanitation.[3]

Global Transportation and Movement

As people and goods cross international boundaries with increasing ease and rapidity, an increase in transport and transmission of infectious disease agents has occurred. Individuals can travel to areas and be exposed to diseases for which they do not have immunity or protection, such as malaria, dengue fever, yellow fever, *Giardia*, and hepatitis B. Most travel can occur in less time than the incubation periods of most infectious diseases, making it possible to become infected while traveling (such as with malaria or SARS), only to return home and become ill and sicken others.[3,98] Tourism travel is not the only source of disease: a total of 2% of the entire global population migrates internationally every year.[3]

The global shipment of goods also has led to the transmission of disease. For example, a U.S. outbreak of cyclosporiasis followed the importation of raspberries from Guatemala in 1997.[99] International transportation of used tires led to the importation to the United States of a mosquito species (*Aedes albopictus*) responsible for transmission of dengue fever in Asia (and transmission of other viruses in the United States such as eastern equine encephalomyelitis).[100] Cholera has likely been spread in ballast water.[3]

Sprawl/Encroachment

As humans continue to spread into areas they have not previously inhabited, including previously forested areas, they come into increasing contact with *zoonoses* (infectious agents in animals) that then have the opportunity to spread to humans. This can occur through direct contact with the previous reservoirs or with other organisms that carry the infectious agent and then spread it to humans, such as rodents or mosquitoes. Guanarito virus, Oropouche fever, Junin virus, Machupo virus, Sabia virus, and Hantaan virus have originated or increased in incidence with land clearance for habitation and agriculture. Increases in malaria incidence have been linked to increased land clearance for agricultural use. Chagas disease, onchocerciasis (river blindness), and leishmaniasis have also increased in incidence and/or geographic spread due to land clearance.[3]

A similar phenomenon (but in reverse) occurs in areas that allow wildlife to return to suburban and urban areas. Increased incidence of Lyme disease in the United States may be due in part to a preference for residence and activity in wooded areas. As suburban areas have been built in more wooded landscapes, as urban and suburban areas have rewelcomed significant vegetation, as farmland has reconverted to woodland, and as humans have turned to more outdoor activities in wooded areas, deer, *ixodid* species ticks that transmit the *Borellia burgdorferi* spirochete, and humans have come into closer contact, leading to greater Lyme disease incidence.[3,19,101]

Breakdown of Public Health Infrastructure

The public health infrastructure is a public good, providing benefit generally, even to those who do not perceive that they use the public health system or that they directly benefit from the public health infrastructure.[102] When that system breaks down, infectious agents have the opportunity to cause great harm. Tuberculosis—which infects about 2 billion people and kills 1–2 million yearly—is a real threat.[91] The World Health Organization declared tuberculosis to be a global emergency in 1993, and directed that directly observed treatment with short-course chemotherapy (DOTS) be utilized to ensure that the 6-month drug regimen required to overcome tuberculosis infection be utilized.[52] Unfortunately, many areas lacked the infrastructure to do this and funding and political support were often insufficient, so tuberculosis continued to spread and increasingly became multidrug resistant (MDR) and extremely drug resistant (XDR).[54,103] DOTS has been determined to cost between $20 and $57 per death averted,[88] making it a highly cost-effective life-saving measure. Public health infrastructures must be intact and sufficiently funded to tackle these and other problems.

Use and Misuse of Antibiotics

Antibiotics have saved millions of lives and prevented many from transmitting infections to others. (Consider only the example of tuberculosis, which has just been described.) However, their use and misuse has led to antibiotic resistance, one of the great threats to health in the coming century.[10] This concept will be discussed later in this chapter in some depth.

Infectivity, Virulence, and Pathogenicity

Infectivity is the quality an organism possesses to produce infection. The secondary attack rate is a measure of infectivity (that is, the proportion of those exposed to the original case that developed infection within the first incubation period). Infection may be apparent or not, as will be described in the following paragraph. This is distinguished from *pathogenicity*, which is the likelihood that a given agent will cause actual symptomatic illness, as opposed to just infection. Pathogenicity can be expressed as the ratio of the number of ill/symptomatic persons over the number infected (not the total number exposed). *Virulence* is a measure of the severity of disease once present. The common cold may be highly pathogenic, but it is not highly virulent. Immunogenicity is the quality an organism or infectious agent possesses to cause the host to mount an immune response such that reinfection with the same agent is prevented. A strongly immunogenic organism confers lifelong immunity, whether through infection or immunization.[25,26,35]

Individuals with inapparent infection are infected but do not have any of the symptoms of infection. Those with inapparent infection may be capable of transmitting infection to others. Those who are contagious despite their own inapparent infection are referred to as being in a carrier state. Hepatitis B,[77] Herpes Simplex virus (HSV-2),[104] *Haemophilus influenzae* type b,[79] and many other infectious diseases have carrier states. These apparently healthy carriers are able to transmit infection.[25,26,35]

To bring these concepts together, smallpox (infection with variola virus) was provided earlier as an example of an eradicated disease. Smallpox had only human

reservoirs—it was not a zoonosis, but an anthroponosis. Transmission was solely human to human, with no vector involvement. Smallpox was highly immunogenic, with infection or immunization conferring lifelong or near-lifelong immunity. Smallpox did not have individuals with inapparent infection or carrier states. All of these factors and others combined to produce an eradicable disease.[34]

Global Burden of Infectious Disease

Now that many of the concepts that permit description of infectious disease as well as an understanding of the distribution of infectious disease have been highlighted briefly, the global distribution of infectious disease will receive brief attention.

Infectious diseases are responsible for 25% of all deaths globally, or 13.3 million deaths in 1998.[105] Just six of those infectious diseases are responsible for 90% of infectious disease deaths: acute respiratory infections (including influenza and pneumonia) kill 3.5 million annually, AIDS kills 2.3 million annually, diarrheal diseases kill 2.2 million annually, tuberculosis kills 1.5 million annually, malaria kills 1.1 million annually, and measles kills 900,000 annually (in 1998).[93] (Measles mortality has recently been declining rapidly in the face of an aggressive international immunization campaign, dropping a total of 500,000 annual deaths between 2000 and 2006.[106]) The WHO reports that cost-effective prevention can avert most of these 13 million deaths.[107]

Although 25% of deaths globally are from infectious disease, in the United States infectious disease is responsible for far fewer deaths. In 1900, four infectious diseases in the United States (pneumonia, tuberculosis, diarrhea/enteritis, and diphtheria) were responsible for a third of all U.S. mortality. By 1999, the top infectious disease killers (pneumonia, influenza, and HIV) were responsible for less than 5% of U.S. annual mortality. However, the spread of the AIDS epidemic, pandemic influenza concerns, the recent geographic spread of Lyme disease and West Nile virus, and growing antimicrobial resistance remind us that infectious diseases remain a threat to the United States and to the world.[3,14,101]

It is important to remember that infectious disease and poverty are strongly interrelated. As has been noted, it would be very difficult to solve one without solving the other. Informed citizens—including chiropractors—will be aware of the roles that poverty, marginalization, social upheaval, and public health infrastructure have in the incidence, prevalence, emergence, and re-emergence of infectious disease. Those who wish to promote health must think beyond the individual (themselves or their patients) to the health of cities, communities, populations, nations, and the world.

SURVEILLANCE: DETECTION AND RESPONSE

Surveillance is a key role filled by public health authorities[2,108] and encompasses a broad range of activities.[109] Among them is watchfulness for the outbreak of communicable diseases.[2,110] Historically, surveillance has played a significant role in reducing the mortality and morbidity associated with these communicable diseases in areas with functioning public health infrastructures.[35,111] In recent times, new threats from emerging infectious diseases stem from changes in demographics, which have brought humans in contact with new diseases and enhanced their spread, as noted earlier.[3,111] The threat of the deliberate release of infectious agents among populations, or bioterrorism, also looms.[2,66] Pandemic influenza poses a grave threat.[14] Surveillance tools must provide rapid and *sensitive* detection and alert to allow appropriate public health response.[2,67,110,112–114]

Surveillance has been defined by the Centers for Disease Control and Prevention (CDC) as "the ongoing and systematic collection, analysis, and interpretation of health data in the process of describing and monitoring a health event. This information is used for planning, implementing, and evaluating public health interventions."[115] Because there are not infinite resources to be watchful for every possible health outcome, surveillance should focus on items of public health importance.[115] Public health surveillance surrounding infectious disease has been selective, and those diseases that are considered *notifiable* change.[116]

The Historic Role of Surveillance in the United States

Late in the 19th century, the U.S. Congress ordered that specific infectious diseases be monitored in foreign nations to improve quarantine measures and prevent the spread of infection to the United States via vessels from these nations. In 1879, mandatory reporting of those diseases commenced, and this directive expanded to states and local authorities by 1893. As technology improved to speed reporting, it was used. The authority to collect and analyze mandatory disease information transferred to the CDC in 1961.[117] There is an annually published directive of nationally notifiable diseases that

reflects ongoing infectious diseases of concern and newly emerging infectious diseases.[116] The *Morbidity and Mortality Weekly Report* conveys information on these notifiable diseases each week.[117]

Surveillance: A Key Public Health Function

The role of surveillance as a key feature of public health was both crystallized and cemented by a landmark report produced by the Institute of Medicine (IOM) in 1988.[108] Traditional infectious disease surveillance has several guises. Surveys, sentinel surveillance, and notifiable disease reporting will be highlighted here.

Health Surveys

It has already been noted that individual and population-level behaviors are implicated in infectious disease incidence and prevalence. Two surveys of national importance and scope are the Behavioral Risk Factor Surveillance System (BRFSS) and the Youth Risk Behavior Surveillance System (YRBSS). The BRFSS has information on adult influenza vaccination rates.[118] The YRBSS has a number of questions related to and implicated in infectious disease, including illegal drug use and sexual behaviors.[119] The National Health and Nutrition Examination Survey (NHANES) has information on hepatitis A, B, and C infection, as well as chlamydia and gonorrhea infection.[120]

Sentinel Surveillance

Sentinel surveillance is a tool that operates at the rapid edge of traditional surveillance. There are multiple types of sentinel surveillance. Several forms of sentinel surveillance are used to track influenza in the United States—some of these systems assess data from the 122 Cities Mortality System, others from the Veterans Administration (VA) and Department of Defense outpatient health care systems, and others from the U.S. Influenza Sentinel Providers Surveillance Network.[121] Sentinel clinics also function to monitor isolated strains for antibiotic resistance in gonorrhea.[122] Another sentinel system monitors health conditions along the U.S. border with Mexico.[123]

Sentinel surveillance includes surveillance of sentinel health events, which are individual health events of which any single occurrence signals a need to improve or monitor public health or clinical health infrastructure.[124] Sentinel surveillance also allows public health authorities to understand what diseases are present in a population without exact information about the number of cases.[125] Sentinel surveillance accelerates and increases the sensitivity of traditional surveillance; however, even sentinel surveillance lacks real-time power and maximum individual resolution.[114] Newer surveillance tools that address some of these difficulties will be described later in this chapter.

Notifiable Disease Reporting

As already discussed, certain diseases are classified as notifiable. When encountered, health care providers and public health authorities report these diseases within states, and most states report them to the CDC. The concept is that certain key infectious diseases and health conditions have particular public health significance and are to be reported and analyzed.[117] There are strict criteria governing what constitutes a correctly diagnosed case.[116] Chiropractors should be aware that states or other authorities may require them to report any of these notifiable diseases should they encounter them in their offices.[126] Chiropractors should be aware of pertinent policy within their locality.

Although strict criteria and laboratory diagnosis lead to high *specificity* in diagnosed cases of notifiable diseases, not all cases are reported or even detected. Further, there is a time delay as specimens undergo laboratory diagnosis. Additionally, clinicians may fail to note clusters of more common symptoms that may herald the earliest stages of an outbreak.[2,67,111,112,127,128] Modern surveillance must consider that rapid, timely notification of the earliest of symptoms in an outbreak may be critical.

Modern Surveillance Need: Emerging Infectious Diseases

A combination of human behaviors and other factors (as previously discussed) continue to give rise to emerging infectious diseases. The appearance of SARS, HIV, West Nile virus, Ebola-Marburg, and other diseases makes it clear that the ability to detect outbreaks of emerging infectious diseases remains essential.[2,67,128,129] Outbreaks of other diseases such as cryptosporidium, cyclosporiasis, norovirus, and influenza, and new potential outbreaks of pandemic diseases, such as H1N1 and H5N1 influenza, are great concerns and make it clear that rapid early detection leading to earlier response and mitigation is key.[2,99,111,113,130–133]

Modern Surveillance Need: Bioterrorism

Surveillance is critical in an era of potential and real bioterrorism.[2,58,66,67,112,114,128–130,133–138] Casualties of hundreds of thousands could be expected, depending on the bioweapon, with potentially disastrous outcome.[58,66,112] Some recent conceptual models have focused on bioterrorist events to help understand and prepare for their potential outcomes. One such model of aerosol releases of various agents projected that an intentional release of anthrax spores affecting 100,000 people could minimally cost $26.2 billion to contain and cause 32,875 deaths.[58]

Modern Surveillance Response: Real-Time Syndromic Surveillance

Automating surveillance to allow near-real-time collection and analysis of health information seems to be essential. The earliest manifestations of an emerging pandemic or bioterrorist event may be increases of vague or nonspecific symptoms, called *prodromes* or *syndromes*.[139] To enable public health authorities to be aware of an increase in syndromes (such as vague respiratory symptoms or gastrointestinal symptoms) that might herald an outbreak of an emerging infectious disease or an act of bioterrorism, attention is being given to broadly capturing in real time whole categories of nontraditional surveillance information.[2,67,140] Some categories of information include emergency department (ED) data, primary care visits, medication sales, and others. The hope would be to capture upswings in prodromal presentations generically through these datastreams, even without knowledge of diagnoses, to detect that an infectious disease event is underway. Such automated real-time surveillance is known as *syndromic surveillance*.

The Realtime Outbreak and Disease Surveillance (RODS) model divides patient presentations into eight syndromes: gastrointestinal, constitutional, respiratory, rash, hemorrhagic, botulinic, neurological, and other.[110,112,135] The information can be transmitted in real time as it is generated, in hourly batches, or in 4-hour, 12-hour, or 24-hour blocks.[114,128,131,135] Various syndromic surveillance statistical and software tools are employed to analyze the information and present real-time reports.[112,114,128,129,133,135,136] By processing electronic information entered only once in real time or near-real time, hours to days may be spared.[110,113,129–131,133,136,137,139,141] This is precious time that could be used to respond to and mitigate the effects of an outbreak.[2,112–114,131,135,137–139]

Surveillance Response

Heymann outlined critical steps to undertake when performing an investigation into an outbreak.[35] When an outbreak is detected by public health authorities, an investigation commences and work is undertaken to contain the outbreak. Steps include establishing characteristics of infected cases (including recording case histories, performing autopsies, tracing out additional cases, etc.), determining who the population at risk for further exposure or disease is and investigating them, developing a hypothesis for the origin of the outbreak, and containing the outbreak. Containment includes managing cases, breaking the chain of transmission,[57] and conducting ongoing surveillance.[35] The last step is preparing a report so that the public health community can learn from the experience; the *Morbidity and Mortality Weekly Report* frequently contains case reports of outbreaks on both large and small scales.[19,35,142] These reports are also published elsewhere and are instructive in understanding outbreaks, as well as how to investigate and respond.[32,35,64,131,143] Methodology is established on investigation of specific types of outbreaks, such as with novel strains of influenza.[144]

Summary: Surveillance

The respective strengths and weaknesses of traditional, sentinel, and syndromic surveillance complement one another, and are used together with benefit.[67,131] Syndromic surveillance complements traditional surveillance by incorporating broader sources of health information in real time or near-real time. Rapid detection permits much earlier investigation and response by public health authorities. This early intervention can save lives and minimize social disruption. Syndromic, sentinel, and traditional surveillance function together to protect public health through rapid detection and response. Chiropractors may have a legal obligation in their localities to participate in the notifiable disease reporting system and fill an important public health role.

IMMUNIZATION

Immunization is a key part of infectious disease control; it is considered one of the great public health achievements of the 20th century.[101] Immunization has been described as one of mankind's greatest achievements.[145] Speaking of the successful eradication of smallpox through a global immunization campaign, Foege stated in an editorial note "For the first time, social justice in public health has

been achieved, with everyone benefiting from a body of scientific knowledge and experience. The benefits will continue to be enjoyed by every person who will ever be born."[146] The WHO, CDC, American Public Health Association, and American Academy of Pediatrics fully support immunization.[147–150]

Although mainstream health care and public health organizations overwhelmingly support immunization, some chiropractors remain antagonistic. In 1994, one third of chiropractors who responded to a survey felt that there was no scientific basis for immunization, that vaccines caused more deaths than they were preventing, and that contracting the diseases they were designed to prevent would be safer than being vaccinated for the disease.[151] More recently, 27% of chiropractors in one survey encouraged patients not to be immunized.[152] Further, 90% of surveyed chiropractic faculty, 80% of surveyed chiropractic students, and 62% of surveyed chiropractic practitioners felt that when supplying patients with information about immunization, both supportive and opposing information should be supplied.[153] A subset of chiropractic students' attitudes towards immunization appears to worsen as they progress through chiropractic education, even if the formal education is nominally supportive.[154] This chapter will work from the assumption that the reader may be skeptical about immunization and will therefore provide a supportive case.

This section will begin with a very brief description of the immune system. Various forms of immunity will be described (natural, artificial, passive, and active), including an introduction to immunization. Population-level immunity (herd immunity) will be explained. Basic immunology information presented in this section is based on reliable texts[155–157] as well as other sources specifically cited. The section will conclude with information about the recommended immunization schedule, the safety of immunization, and finally the importance of supporting immunization efforts. It will hopefully be clear that immunization programs are worthy of wholehearted support, with smallpox eradicated, polio close, and measles rapidly reducing, all with effective immunization programs.[158]

The Immune System (in Brief)

The immune system is composed of *innate* and *adaptive* components. The innate component is a rapid-response system that reacts to antigenic *epitopes*, the molecular patterns on the surface of antigens that identify antigens as being other than "self" and therefore necessary to defend against. The innate system produces a generic response that functions well under most circumstances. In those instances where a more specific and trained response is necessary, the innate system helps to start and guide the adaptive immune system.

The adaptive immune system consists of T and B cells (both lymphocytes), and takes some time to train. Each T cell and B cell responds to one and only one antigenic epitope. The B cells (which produce antibodies) recognize antigens without the help of any other cell or molecule. T cells recognize individual antigens, but also require the assistance of individual major histocompatibility proteins, called human leukocytic antigens (HLA). (HLA-B27 should sound familiar to many chiropractors because of its role in seronegative spondyloarthropathies.) Each T cell responds to exactly one antigenic epitope in combination with exactly one HLA.

In general terms, the innate system responds generically to patterns of proteins that are present in non-self antigens. The innate system must ward off antigens while the adaptive system prepares tailored antibodies (also called immune globulins) and activated T cells and other cells that can eliminate or suppress the antigens when a more tailored response is required. Also in general terms, the adaptive immune system functions as B cells respond by producing antibodies (immune globulins) that label antigens for destruction and as T cells destroy antigens presented to them by cells with which they are histocompatible (a combination of the correct HLA protein and the correct antigen).

This is a simplified description, but it is sufficient to begin to describe the important role immunization plays in preparing or training the immune system in advance to be able to respond more quickly and robustly to important antigens upon exposure, and the role that immune globulins play in helping the immune system ward off infectious disease (such as rabies or hepatitis B) after exposure. It is also sufficient to describe the safety of immunization, and understand how the interaction of individual choices and population-level rates of immunization interact with organism factors to allow disease eradication (such as smallpox and almost polio), sporadic outbreaks (such as pertussis), regular epidemics (influenza), or serious ongoing major threats to health (such as tuberculosis, pneumonia, influenza, and measles).

Forms of Immunity

Naturally acquired immunity is just as it sounds—the development of immunity through natural means. Naturally acquired adaptive immunity is the development

and training of the adaptive immune system in response to infection or exposure to an infectious agent. Naturally acquired passive antibody-mediated immunity refers to the temporary passive immunity transferred to the infant from the mother via immune globulins that have crossed the placenta or were transferred through breast milk.

Artificially acquired immunity is acquired through some form of immunization. When prophylaxis is required after rabies, or hepatitis exposure, it is important to respond quickly so that lethal or serious infection does not ensue. Immune globulins can be administered by injection and provide an artificially acquired passive antibody-mediated response to these agents. Surveys about chiropractic attitudes towards immunization tend to refer less to this artificially acquired passive immunity (such as immune globulins after rabies exposure) and more to artificially acquired adaptive immunity (such as measles vaccination).

Artificially acquired adaptive immunity is produced in response to immunization, which is provided to prevent infection from a variety of agents (e.g., tuberculosis, pneumonia, measles, diphtheria, yellow fever, smallpox, polio). This process of artificially acquired adaptive immunity saves the lives of 2–3 million people every year.[159]

Population-Level Immunity: Herd Immunity

When a sufficient proportion of the population has developed immunity against a given infectious agent, whether through a history of overcoming infection (naturally acquired immunity) or through immunization (artificially acquired immunity), herd immunity develops against that agent. Herd immunity describes the situation when enough people in the community are not carrying the agent, such that the infectious agent "dead ends" in immune hosts, or is not contacted during the period of communicability, and thus does not spread to susceptible hosts in a way that sustains the agent in the population. Those who are not immune become less likely to be infected at any given time, though they are, of course, still vulnerable to infection under the right circumstances.[160]

Groups that are protected by herd immunity thanks to those who have been immunized include the very young (who are vulnerable to diseases they may still be too young to be immunized against), those with immune suppression in some circumstances, those with leukemia, and those who did not develop an adequate immune response when immunized.[160,161]

Recommended Immunizations

The currently recommended immunization schedule in the United States is published by the CDC. For children under 6 years of age, 11 immunizations are recommended on a fixed schedule, with a catch-up schedule provided. The 11 recommended immunizations are hepatitis B, rotavirus, DTP (diphtheria, tetanus, pertussis), *Haemophilus influenzae* type B, pneumococcal, inactivated poliovirus, influenza, MMR (measles, mumps, rubella), varicella, hepatitis A, and meningococcal.[162] Additional information is available regarding immunization for other age groups and situations.[163]

The CDC has special recommendations for those who work with vulnerable populations (e.g., with children, with the elderly, or in a health care setting). For those who work in health care settings, the CDC states that they are likely to have patients vulnerable to disease or to complications of disease. "Make sure that you have all the vaccines you need, including annual influenza vaccination. When you are properly vaccinated, you protect yourself from sickness and you avoid acting as a carrier for diseases."[163] For the public's benefit, chiropractors should carefully consider the advice of the CDC.

The Safety of Artificially Acquired Adaptive Immunity: Vaccination

Immunization/vaccination is widely considered safe. Nearly 2 billion doses of vaccine were distributed in the United States between 1991 and 2001. Among these 2 billion doses, a total of 128,717 adverse reactions were reported to the Vaccine Adverse Event Reporting System (VAERS). This system contains voluntary reporting of incidents that occur with any temporal association to vaccination; however, no cause or effect inferences can be drawn from it. The most common reported reaction to immunization was fever (25.8% of adverse events, or 33,172 reported incidents in 2 billion doses). Of those 128,717 adverse reactions, 18,296 were reported to be serious. Of those 18,296 serious reactions, 1.4–2.8% were deaths. However, with additional investigation of the 206 deaths from the 1990–1991 period reported to the VAERS system, only one was found to be attributable to vaccination.[164] If one death from each of these years could be attributed to immunization, then immunization in the United States may have resulted in 11 deaths between 1991 and 2001. Meanwhile, immunizations prevent 2 to 3 million deaths per year around the globe while an

additional 4 million children die of vaccine-preventable disease.[159] Some people hold safety concerns about vaccination other than simply the risk of death; this will be addressed later in the chapter.

Immunization is one of the safest and most cost-effective public health interventions available.[159,164,165] That is not to say that artificially acquired immunity is not without risk—the risks are just extraordinarily less than allowing these diseases to operate freely among populations. In fact, it could be questioned if opposition to vaccination among those who live in a highly vaccinated population and have therefore not encountered death and disability from measles, meningitis, diphtheria, rotavirus, rubella, polio, tuberculosis, yellow fever, and others is based on lack of exposure and appreciation of the infectious disease reality faced by billions around the globe—and which is largely kept in check around them by a public health infrastructure highly supportive of careful immunization. However, some people have many safety concerns about immunization. Many such concerns will be addressed here. (Concerns regarding libertarianism, government control over health choices, and other philosophical considerations will not be discussed here; however, those arguments underpin all of public health, and are not unique to immunization.)

Myth: Immunization Causes Autism

A 1998 study of 12 children proposed an indirect causal link between certain environmental factors (including vaccination in particular) and autism—though the interpretation was recanted by 10 of the 13 authors in 2004.[166–168] Other better conducted studies have since resolved the issue. For example, a study of every child born in Denmark between 1990 and 1996 (467,450 children and 2,986,654 person years) compared children vaccinated with and without vaccinations containing thimerosol, the mercury-containing compound frequently blamed by some for the purported autism link. The rate of autism in the two groups did not differ significantly. Additionally, there was no detected dose-response between amount of thimerosol exposure and risk of autism diagnosis.[169] Those who are (rightfully) concerned about the apparent rise in autism diagnoses should consider other factors as culpable: increased awareness of autism, improved diagnosis of autism, and changes in diagnostic criteria, among other possible factors.[170] Children develop and are diagnosed with autism in the same age period in which vaccinations are administered—this temporal relationship is not a causal relationship.[168] The reason very large scale studies are conducted (such as the Danish study reported here) is to prevent this bias of false temporal association and to improve the likelihood of detecting true relationships. An apparent increase in autism diagnoses is a cause for concern, but immunization appears to be the wrong place to put the blame.[171]

Myth: Vaccination Overloads the Immune System

There are some who do not keep up with immunizations because they have a concern about immune system overload.[172] There appears to be no evidence of an overload of the immune system; rather, infants and young children have an enormous ability to respond to immunization and develop responses that will then protect them from various childhood illnesses.[173] How robust is the infant immune system? Theoretically, based on the number of B cells per milliliter of blood, the growth rate of B cells, the amount of antibody needed to be produced to be effective, the rates of antibody production, the number of antigens present in a vaccine, and so forth, an infant could theoretically respond to 10,000 vaccines at once. Giving an infant all 11 vaccines at once would therefore theoretically tax a total of 0.1% of an infant's immune system. As further proof, a wide range of immunizations are frequently combined, and there is no diminishment in efficaciousness.[174]

Myth: More People Get the Disease from the Vaccine

This may once have been true about polio vaccination in the United States up until 1997,[164] when seven people contracted polio from the vaccine; however, the live polio vaccine is no longer used in the United States, because most of the globe has been successful at polio immunization, and only a few pockets remain where polio is endemic. This will be discussed again later in this chapter.

As mentioned earlier, 2 billion doses of vaccination were distributed in the United States between 1991 and 2001.[164] The number of individuals who received vaccinations who then contracted the disease cannot be determined through the VAERS information available. However, if it is assumed that *all* of the reported serious diseases contracted around the time of the immunization were vaccine-induced disease (which is highly unlikely), then the 2 billion doses of vaccine could have resulted in 200–300 reported cases of disease annually (again, this is likely a *very* high estimate). This would result in a risk of contracting disease from the vaccine of

about 0.0000011 to 0.0000017. Conversely, the risk of contracting pertussis, influenza, measles, diphtheria, or other vaccine-preventable diseases is very high upon exposure in susceptible populations (non-immunized, non-previous exposure). Prior to the development of the measles vaccine, about 100 million people contracted measles annually with a 6% case fatality rate.[175] Influenza attack rates range from 10% to 50%.[48] Pertussis has a 90% secondary attack rate.[176] Anyone who is not immune to diphtheria is susceptible, with noncutaneous diphtheria having a case-fatality rate of 5–10%.[177] More people do not get the disease from the vaccination, and—contrary to the next myth—it is not safer to get the disease than the vaccination.

Myth: It Is Safer to Have the Disease Than the Vaccine

As noted, even if every serious disease reported was an onset of the disease due to immunization, there are very few diseases temporally reported to be attributed to 2 billion doses of vaccination. But even considering the 18,296 serious adverse events reported compared to 2 billion doses, the risk of any reported serious adverse event is about 0.000009 per dose.[164] Meanwhile, in unvaccinated populations, hepatitis B kills 1 million people annually[77]; diphtheria, tetanus, and pertussis (DTP) kill a combined 496,000 children under 5 years of age annually; *Haemophilus influenzae* type b kills 386,000 children under 5 years of age annually; and pneumococcal illness kills 716,000 children under 5 years of age annually.[178] The diseases these vaccines prevent cause millions of deaths whereas conversely, millions of deaths have been prevented by the vaccines—and there are only thousands of adverse events reported in context of billions of doses administered in the United States.[159,164,178]

There are some who point to the swine flu vaccine of 1976 and the associated Guillané-Barre syndrome developed by about 500 and the Cutter Labs polio incident in the 1950s as evidence that vaccinations are more dangerous than the diseases.[159] Although the number of deaths vaccines prevent every year may be a sufficient counterargument to this for some, these specific incidents are addressed here.

The 1976 Swine Flu Vaccine and Guillané-Barre Syndrome

The excess risk of Guillané-Barre syndrome was 1 in 100,000 during that course of swine flu vaccination in 1976.[179,180] As tragic as these cases of Guillané-Barre syndrome are, they pale next to the number of those that die from influenza in the United States annually. Morbidity and mortality associated with influenza have been demonstrated to be reduced through vaccination for influenza.[15,48] It is not yet clear precisely what the reason for the relationship between that swine flu vaccine and Guillané-Barre syndrome was; however, it is important to remember that Guillané-Barre syndrome does continue to occur naturally, and the excess occurrence (occurrence above that normally expected) with the swine flu vaccine was about 1 in 100,000.[179,180]

The Cutter Labs Polio Incident

The Cutter Labs incident is also tragic. In the 1950s, an improperly prepared live polio vaccine led to many illnesses, some cases of paralysis, and 10 deaths.[159] This was indeed a tragedy, but it must be remembered that the overall drive to eliminate polio has been enormously successful. As Foege said about the eradication of smallpox, if polio is successfully eradicated, it will be a gift given to every child who will ever be born.[146] Polio cases have dropped 99% since 1988 in the face of a Global Polio Eradication Initiative.[181]

It must be remembered that the risk of acquiring polio from the vaccine is gone in the United States and Canada because the live vaccine is no longer given there. The last seven cases of polio acquired from the vaccine in the United States occurred in 1997.[164] As the vaccination and surveillance drive has been successful, endemic polio was declared eradicated in the Western Hemisphere in 1994.[182] Through determination, perseverance, and enormous international cooperation, polio is going the way of smallpox—and if the political support and cooperation continue, hopefully it will completely go the way of smallpox. Annual polio incidence has declined from 350,000 cases in 1988 to 1300 cases in 2007.[181] Immunization for polio must continue until the disease is eradicated, to avoid an epidemic or pandemic in the unimmunized if the disease were able to be transmitted outside of the pockets where it continues to circulate. When the disease is eradicated, all polio vaccination will discontinue, just as smallpox has.

The deaths from these separate incidents are not to be minimized, but they must be put in context: millions of lives have been spared suffering and death by these vaccines, and polio may soon be eradicated forever.

Importantly, the number of serious adverse events that have an association with vaccination in the United States (per VAERS) is over 18,000 per year, compared to 2 billion

doses. To put this in context for chiropractors, the risk of severe adverse events from spinal manipulation and from vaccination both are quite small (i.e., 1 per 1 million).[183] There are obviously (different) high risk groups for both vaccination and manipulation for whom other therapies may be more appropriate for the respective health conditions they address, but in general, both therapies seem to be of minimal risk of serious adverse events (such as death and permanent disability) for most people.[164,184]

Myth: There Is No Scientific Evidence for Immunization

Extensive research regarding the safety and efficaciousness of vaccination has been undertaken, and continued monitoring is undertaken to detect adverse events and risks in order to minimize them.[148,164,180,185] Although it is clear that factors other than immunization are also responsible for infectious disease declines,[186,187] it is also clear that immunization is responsible for saving millions of lives per year—and that millions more lives could be saved each year from mortality stemming from vaccine-preventable diseases.[159] In some areas, chiropractors may not be able to discuss vaccination because of scope of practice issues.[183] However, where chiropractors are able to discuss the issue, an understanding of public health principles and of the safety record and track record of immunization should help prompt chiropractors to express more positive sentiments with more confidence about this life-saving public health tool. People who are not immunized can contribute to potential disease in themselves, as well as in others at risk (whether non-immune because of age, leukemia, immunosuppression, or other factors as previously discussed). Increasing numbers of school outbreaks, even among a small proportion of those children who were immunized (but did not uptake full immunity), are associated with increasing numbers of individual exemptors to immunization.[161] There is scientific evidence for immunization, and evidence of increasing risks with exemption from immunization.

Summary: Immunization

Vaccines are not perfect. They are not 100% effective.[161] They are not wholly without risk.[164,185] However, the same can be said of chiropractic manipulation. Like chiropractic manipulation, vaccines appear to be safe in most people most of the time. Additionally, vaccines have prevented and will continue to prevent millions of deaths and much disability from the consequences of preventable disease. Immunization programs successfully eradicated smallpox. They have almost eliminated polio. They have greatly decreased cases of measles and measles-related mortality. Immunization is an important part of infectious disease control that includes hygiene, sanitation, appropriate use of antibiotics, and other tools.[101]

RESISTANCE AND REEMERGENCE

The appropriate use of antibiotics is a key part of control of infectious diseases, which is considered one of the 10 great public health successes of the previous century.[187] However, the CDC reports that "Nearly all significant bacterial infections in the world are becoming resistant to the most commonly prescribed antibiotic treatments."[188] This section will highlight some of the successes of antibiotics, the general mechanisms of development of resistance, and the significance of the reemergence of infectious disease threats because of antimicrobial resistance.

Antibiotic Successes

Sulfonamide began use as an antibiotic in the 1930s. Penicillin began large scale usage during World War II and the decade thereafter.[189] Through the rest of the 20th century, a variety of antibiotics were developed and employed. These played a potent role in the control of tuberculosis, gonorrhea, syphilis, streptococcal and staphylococcal infections, pneumonia, and many other bacterial infections. Other chemotherapeutic agents were developed and discovered to have an impact on viral infection.[40,46,48,77,78,190] Through the middle of the century, with antibiotics and chemotherapeutics working well, infectious diseases like smallpox coming under control, and many vaccines in development, infectious disease mortality was in a nearly continuous decline.[186] In 1970, the U.S. Surgeon General is reported to have stated that the war with infectious diseases was successfully over.[191] The life-saving role of antibiotics is undisputable when they are properly used.[187]

Resistance Mechanisms

Unfortunately, the use and misuse of antibiotics have led to microbial resistance to those antibiotics and chemotherapeutic agents. Infectious agents have developed resistance to antibiotics through two major mechanisms in response to human activities, generally stated in the following sections.

Biologic Factors Contributing to Resistance

Those organisms that survive antibiotic usage possess traits that allow them to resist antibiotics. Such selective pressure greatly favors resistance over time. As microbes multiply quickly, organisms with resistant traits have the opportunity to increase in number, and the proportion of microbes that are resistant is likely to grow as susceptible organisms are killed. In the simple sense, biologic diversity (including the presence of resistant traits) allows resistant organisms to prosper through selective pressure via antibiotic usage.

The other trait that allows resistance to spread among infectious organisms is the ability for infectious organisms to be involved in horizontal gene transfer—the transfer of genetic information between organisms.[8,155,192] Through a variety of mechanisms that will not be described here, it is possible for bacteria to acquire genetic information directly or indirectly from other bacteria. Genes that code for proteins that favor resistance can be transferred among organisms, potentially speeding the process of resistance already favored through selective pressure.[8] The possibility that infectious disease organisms could become immune to all typical therapies is very real.

Behavioral Factors Contributing to Resistance

According to the World Health Assembly Resolution of 1988, the following items were stated to contribute to antimicrobial resistance: the use of antimicrobials without a prescription in humans or livestock; poor infection control practices; counterfeit antimicrobials; informal antimicrobial sales; and failure to detect resistant organisms, monitor antimicrobial usage, or study the effectiveness of control programs.[10] These behaviors allow antimicrobial resistance to develop and thrive and will be discussed briefly.

Antimicrobials in livestock feed are a large source of antibiotic use without a prescription—up to 70% of antibiotics and related drugs in the United States are used in livestock.[193] Many of the antibiotics used in this feed are also used in people, helping livestock potentially accelerate resistance in organisms of concern to humans.[65] Antimicrobials are in many everyday products, and the presence of low-level antimicrobials in the consumer environment may play a role in the development of resistance.[194] Poor infection control practices—whether in nations (with insufficient public health infrastructure), health care facilities (with failure to follow standard protocols to control infectious disease), or homes (with using prescribed antibiotics improperly)—allow resistant organisms to prosper. About 2 million people contract infectious diseases in hospitals in the United States annually, a number that represents almost 5% of acute-care admissions. As many as 70,000–99,000 will die of health care–acquired infections annually.[195,196] This problem is grave because health care–acquired infections are often resistant to antibiotics, are pathogenic, and are easily transmitted.[196] The specific problem of health care–acquired infection will be addressed briefly later in this chapter, but it is part of a larger picture: infectious disease control plays a critical role in preventing antibiotic use, overuse, and misuse. The behaviors outlined by the World Health Assembly lead to antimicrobial resistance and must be addressed.[10]

The World Health Organization Global Strategy for Containment of Antimicrobial Resistance outlines steps to fight the spread of resistant infectious disease organisms.[10] This thorough strategy covers key areas, from surveillance, to antibiotic usage, to infection control. The success of these efforts will determine whether declines in infectious disease mortality over the previous century—assisted in part through the appropriate use of antibiotics—will persist or reverse.

Case Studies in Resistance

The first reported cases of penicillin resistance in *Staphylococcus aureus* were noted in 1944, only a few years after usage of penicillin began. Resistance became widespread in health care settings—specifically hospitals—but *S. aureus* was generally still susceptible in the community. However, resistance to penicillin rapidly grew, so that within about 6 years, 25% of *S. aureus* infections in hospitals were resistant. By the 1970s, 70–80% of all *S. aureus* infections were penicillin resistant. A similar pattern occurred in *S. aureus* after the introduction of vancomycin in 1956 and methicillin in 1961. It took about 40 years for resistance to reach 25% in hospitals for vancomycin, and less than 1 year for methicillin. Methicillin resistance is probably present in about 50% of strains in the community.[11]

Of concern is the potential development of *Staphylococcus aureus* that is not susceptible to methicillin, penicillin, or vancomycin. As noted, many bacteria are able to transfer genetic material horizontally. Vancomycin-resistant enterococci (VRE) are spreading rapidly and transfer resistance horizontally with ease.[197] The fear is that MRSA strains will develop full

vancomycin resistance (already appearing) through horizontal gene transfer or other means.[198]

Fluoroquinolones were approved for use as antibiotics in poultry water in 1995 and 1996. The antibiotic was promoting resistance to *Campylobacter jejuni* in poultry; *C. jejuni* is one of the most common bacterial causes of foodborne illness in humans in the United States and is present in very large numbers in poultry feces. However, because the antibiotic in the poultry water was the same antibiotic used to treat *C. jejuni* infection in humans, the use of this antibiotic in livestock was promoting antibiotic resistance of *C. jejuni* in humans. The Food and Drug Administration (FDA) withdrew approval for the use of fluoroquinolones in poultry feed in 2005.[65]

HIV, herpes viruses, hepatitis viruses, and influenza viruses have all demonstrated resistance to antivirals.[199] Influenza A displays high resistance to amantadine and rimantidine[200] and is also showing early resistance to oseltamivir, including in potentially pandemic strains and highly pathogenic avian strains.[132] Antimicrobials, antivirals, and chemotherapeutic agents are powerful tools, but resistance is a real threat. As this section has emphasized, human behavior is key to infection control generically, and development of—or prevention of—antimicrobial resistance specifically.

Reemergence

The CDC reports that gonorrhea, malaria, tuberculosis, *Streptococcus pneumoniae*, and other diseases have also developed resistance to antibiotics.[201] Each of these may be considered a re-emergence of a disease once considered controlled.

Neisseria gonorrhoeae—once easily controlled with penicillin—now has strains showing resistance to penicillins, tetracyclins, spectinomycin, fluoroquinolones, ciproflaxin, and ofloxacin.[11] Only one class of antibiotics remains that is recommended for treatment.[122]

Malaria species first began showing resistance to chloroquine in the 1950s and 1960s. *Plasmodium falciparum* has shown resistance to almost all available treatments in various geographic areas. *Plasmodium vivax* began showing resistance to chloroquine in 1989, and now also displays resistance to primaquine in some areas. Multidrug-resistant malaria could become a serious threat.[12]

Currently, 5% of all new infections of tuberculosis around the globe are known to be MDR strains. In some areas, as many as a quarter of all new infections are MDR strains. XDR strains have been reported in 45 countries. At 9 million new cases of tuberculosis per year, this is a serious and growing problem, as tuberculosis reemerges as a public health threat.[13]

Streptococcus pneumoniae has developed significant resistance recently, including multidrug resistance. In 1998, almost 30% of strains showed resistance to penicillin, with 17% showing intermediate resistance. This was an increase in resistance of nearly 40% in some locations from surveys conducted just 3 years prior.[202] Vaccination with pneumococcal conjugate vaccine is preventing infection from as many as 80% of resistant strains, but outbreaks continue to occur. The emergence of resistant pneumococcal strains is of real importance.[203]

The infectious diseases given specific mention here should be understood to be representative of a much larger trend, and not an exhaustive discussion by any means. The reemergence of infectious diseases is an important part of the overall story that includes emerging infectious diseases, growing antimicrobial resistance (as discussed here), and health care–acquired infection.

HEALTH CARE–ACQUIRED INFECTION

As noted earlier, there are up to 99,000 fatal health care–acquired infections per year in the United States, and up to 2 million total health care–acquired infections.[195,196] Many of these infections are resistant to at least one drug that would otherwise have been used to treat them.[196] The infections stem from a variety of causes,[195] and many processes have been studied to combat antimicrobial resistance in hospitals.[204]

Although chiropractors may consider health care–acquired infection to be a problem of other health care providers or other health care facilities, they also need to consider their role in this serious public health problem. One chiropractor famously caused an outbreak of amebiasis in six patients undergoing colonic irrigation.[205] Although this may be an extreme case, consider the possibility of the spread of MRSA infection.

Chiropractors and MRSA

Methicillin-resistant *Staphylococcus aureus* (MRSA) is of increasing concern in health care settings and in the community, with the most serious concern being invasive cases of MRSA. There were nearly 9000 such cases in the United States in 2005, most of which were health care–acquired MRSA (HA-MRSA) infections.[9] However, about 50% of the strains of *S. aureus* throughout the community may be methicillin resistant.[8] MRSA is not just a problem in health care facilities such as hospitals.

When MRSA is transmitted without the infected person having been admitted to a hospital or having undergone a medical procedure in the previous year, the MRSA is considered community acquired (CA-MRSA). If transmission occurred through contact with a chiropractor's skin, clothing, treatment table, treatment equipment, or surface in the office, this would be considered CA-MRSA.[9,42] MRSA and other infectious agents can be transmitted through the clothing, hands, and equipment of health care workers.[42–44,143,206]

MRSA has been found on chiropractic tables through very routine searches of just a few tables, so it is clearly present in chiropractic offices.[37,38] Simple disinfection procedures can sterilize vinyl-surface chiropractic tables, but it is unclear if cloth-surfaced chiropractic tables would respond to standard disinfection procedures.[38] Skin-to-skin transmission is a common source of MRSA acquisition[42] and is very important in CA-MRSA,[44] but effective use of barriers can effectively prevent the transmission of MRSA even in very sensitive health care situations.[207] MRSA can remain viable on certain health care surfaces for 9–12 days or more.[43] Physicians' coats—particularly at the cuffs and pockets—are frequently contaminated with infectious agents.[206] Because MRSA can readily survive in the environment and on cloth surfaces, because it can transfer from health care workers (who can carry and transmit it), and because skin-to-skin and fomite-to-skin transmission are important with MRSA, chiropractors and chiropractic offices might play a serious role in the transmission of CA-MRSA.

Chiropractors are in very close physical contact with the patients they treat with more than their hands. (The upper and lower extremities and thorax of the chiropractor can all be in contact with the patient to provide leverage for forms of manipulation.)[208] Even if hands are washed and tables disinfected before and after patient contact, clothing is not. Exam equipment (pinwheels and hammers), treatment equipment (ultrasound heads), and other materials may not be appropriately disinfected before and after visits.

Chiropractors should consider that if physicians' coat cuffs are likely to carry infectious organisms,[206] chiropractors who may have more extensive physical contact with their patients may potentially be an important community carrier of MRSA. Additionally, chiropractors treat patients who may be disrobed for portions of the therapy. It is unknown if the state of dress in the chiropractic office affects the likelihood of transmission of organisms to or from that patient or to or from the chiropractor. However, the role of skin-to-skin and fomite-to-skin transmission is established, as has been noted. Chiropractors may want to consider the role that simple barriers could play to help break transmission cycles and still allow for therapeutic touch without undue burden to provider or patient. This is a public health concern that does reach chiropractors in their offices and clinics.

If it is determined in the future that chiropractors (and other health care professionals outside the definition of HA-MRSA) are a source of CA-MRSA—and further that effective barriers and other procedures can prevent this spread—then policies may need to change to reflect this. It has been noted that CA-MRSA may have a different pathogenesis then HA-MRSA—skin-to-skin and fomite-to-skin contact may be particularly important.[44] This could be critical for chiropractors to consider. "A systematic infection control protocol may not be in place for the chiropractic profession and is clearly needed."[38(p.e4)]

Standard Precautions

One important step in infection control in the chiropractic office and in any health care setting is the use of standard precautions. Standard precautions assume that all blood and bodily fluids except sweat, any nonintact skin, and mucous membranes contain transmissible infectious agents, and that appropriate barriers and other measures should be used before, during, and after interactions between patients and providers.[209] (Intact skin may very well harbor MRSA or provide a source of transmission.[44]) Handwashing is critical before and after patient contact. Disinfecting the table at the beginning, middle, and end of the day may suffice in many chiropractic offices (providing disposable paper is used), but the table should be actively cleaned and disinfected if it becomes soiled.[209] More frequent disinfection may be warranted.[38,44] Patients who may have breaks in the skin might expose the chiropractor, the table, or other patients to blood. Face paper and headrests may become soiled. Standard precautions should be familiar to the chiropractor and their staff, and offices should have policies in place to deal with blood, bodily fluids, nonintact skin, soiled surfaces, and other situations to protect themselves and others from transmission of infectious disease within their clinics—and to be compliant with regulations in their localities. The CDC provides an overview of important infection control procedures, as do others.[38,209] In an era of microbial resistance, MRSA, and heightened concern about infectious disease,

chiropractors should work to ensure that their offices do not facilitate transmission.

Immunization

Earlier in this chapter, the CDC recommendations for immunizations for health care providers were discussed. Chiropractors can be asymptomatic carriers of important infectious diseases if not appropriately immunized. Per the CDC, "Make sure that you have all the vaccines you need, including annual influenza vaccination. When you are properly vaccinated, you protect yourself from sickness and you avoid acting as a carrier for diseases."[163]

Summary: Heath Care–Acquired Infection

Health care–acquired infections are an important source of morbidity and mortality in the United States. The infections are frequently resistant to drugs that might treat them, the resistance often having developed or been favored in these settings. Chiropractors may play an undetermined role in the transmission of CA-MRSA in their offices, if disinfection and barrier protocols—as well as simple handwashing—are not appropriately utilized. The CDC recommends that health care providers be immunized to prevent serving as carriers of infectious agents to vulnerable populations. Health care–acquired infection is an important area of public health concern; chiropractors have an important role to play in helping to break the cycle of transmission.

PUTTING IT ALL TOGETHER: INFLUENZA A AND PANDEMIC INFLUENZA

Some may wonder why the CDC would recommend annual influenza vaccination for health care providers. In this concluding section of this chapter, all of the themes surrounding infectious disease that have been discussed thus far will come together in the discussion of pandemic influenza.

Influenza: Brief Background

Influenza epidemics and pandemics have occurred at least since the days of Hippocrates.[210] In temperate climates, such as in North America, epidemics have occurred with regularity in the winter year after year.[15,48,210] The annual global excess death toll attributed to influenza A is currently about 1 million.[48] In the United States, influenza kills about 20,000 people annually.[15] In 1918, a massive influenza A pandemic swept the globe, killing 20–40 million (and perhaps 50 million) people overall and nearly 700,000 people in the United States, with total infections of about 500 million people. Two other influenza A pandemics occurred in the 20th century, with one causing 66,000 excess deaths in the United States.[15,210] More recently, the H1N1 'swine flu' pandemic has been of public health interest. While this section largely refers to avian influenza, similar fears surround the present H1N1 influenza.

The Influenza Virus

The influenza A virus is an enveloped, negative-strand, eight-segmented, RNA virus. The eight segments of the RNA code for 10 proteins. Two of those proteins are hemagglutinin (HA or H) and neuraminidase (NA or N), antigenic surface proteins that impact the virulence and pathogenicity of the virus.[15,48,132,210]

NA Proteins

The NA proteins facilitate the exit of influenza viruses from host cells.[132,210] This allows the virus to spread in secretions.[132] The NA protein has a few existing numbered variations (of which nine are carried in bird/avian species), and along with the HA protein is considered a major antigenic determinant (though it is not the focus of antibodies that HA is).[132,210] Because the NA protein facilitates exit from cells, it can be said to play a role in the virulence and transmission of influenza A. This protein is also the subject of the NA inhibitors oseltamivir and zanamivir, two important antiviral drugs utilized in the prophylaxis and treatment of influenza A.[46,132,211]

HA Proteins

HA proteins have a highly conserved core—the few existing variations are numbered (such as H1, H3, H5, and H7). The antigenic properties of the HA protein largely determine the virulence and pathogenicity of the influenza A virus. Of the 16 HA protein subtypes that circulate in avian species, 6 have been shown to infect humans. HA proteins are primarily targeted by antibodies, making these proteins the focus of vaccines; however, the core HA proteins have surface epitopes that are constantly changing slightly. These constant slight changes are referred to as *antigenic drift*, and are the reason that the vaccine must be reformulated annually and that there are near-annual epidemics of influenza.[15,48,132,210]

Influenza Viral Proteins in Epidemics and Pandemics

Even though many or most people in a population may be somewhat immune to the primary core HA influenza protein circulating (such as H1), most are largely not immune to the new strain circulating each year (though that varies with how different the annual strain is—based on drifting epitopes—compared to earlier strains). Annual or near-annual epidemics therefore occur in response to this antigenic drift.[15,48,132,210]

Pandemics occur for a different reason. Occasionally the core HA protein (or core NA protein) in circulation exchanges, perhaps from H1 to H2, H3, H5, or H7. Under such circumstances where essentially no one has been exposed to that new core protein, there is little to no existing immunity to that strain of influenza in the population and the strain is said to be novel. This switch of core protein is referred to as *reassortment*.[15,48,132,210]

Reassortment occurs because of potent features of the influenza virus. HA proteins bind to receptors in humans, avian species, and swine, with swine and humans having both their own receptors and receptors favored by avian strains. Human and swine hosts are therefore referred to as *mixing vessels*. When two strains of influenza infect the same cell in *coinfection*, one strain may adopt the core protein from the other, such as adopting H5 instead of retaining H1. This reassortment produces *antigenic shift*, and represents the production of novel strains of influenza incorporating new HA or NA strains, to which many or most are immunologically naïve. If the new virus can transmit easily, is highly pathogenic, and is highly virulent, a pandemic may occur. This occurs every few decades and was the reason for the global pandemic of 1918/1919.[15,48,132,210] Many have likely heard of H5N1 influenza, one of the avian strains of greatest concern presently.[212]

The threat is that avian H5, H7, or H9 proteins may be incorporated into an easily transmitted human influenza A virus. These proteins are novel in human infection (previous pandemics were H1, H2, and H3 strains), so it is felt that the consequences of this inevitable reassortment to a successful strain could be devastating.[14,15,89,132,210,213] The 1918 epidemic was devastating because it was a novel H1 strain. For the 30 years prior to 1918, the H3 strain had been circulating. This meant most were susceptible to a new core HA protein in 1918 (H1)—and young adults were particularly struck, because the elderly had some immunity to the H1 core protein, having survived the prior H1 pandemic a few decades previously. Selection pressure may favor a new pandemic strain that incorporates a novel HA or NA protein every 10–30 years or so.[15]

Medical Treatment

In general, treatment of confirmed cases of influenza A is by oseltamivir and zanamivir. Resistance to two antiviral medications (amantadine and rimantidine) has led to their discontinuation until susceptibility can be reestablished.[46,132] Oseltamivir and zanamivir are both NA inhibitors and are also used in treatment of avian influenza in humans, though one case of resistance to oseltamivir in a young girl with a highly pathogenic avian influenza (HPAI) H5N1 has been documented already.[132] However, these medications have shown usefulness with H1, H2, H3, H5N1, and H7N7 influenza A subtypes, as well as with influenza B.[89]

The Epidemiology of Influenza A

This chapter has previously covered a range of factors that influence the distribution of diseases in populations. In this section, the factors that influence the distribution of influenza A will be discussed, using terms now familiar.

Incidence and Prevalence

The precise incidence and prevalence of influenza A are difficult to determine. Clinical diagnosis is not a reliable measure.[46] Laboratory diagnosis is obviously not conducted on every individual with flu-like symptoms; however, the percentage of positive laboratory tests is an important marker, and increases during influenza epidemics.[214] Additionally, the number of hospitalizations and deaths attributable to influenza can be determined.[48,215,216] Further, syndromic surveillance systems capture influenza-like illness, though they are naturally over-sensitive.[217]

Infectivity

The size of the inoculum required will vary greatly from individual to individual, based on strain, infection history, immune response, overall health, underlying or chronic conditions, and so forth. However, the virus should be considered highly infective, because epidemics occur every year or almost every year. One study that introduced the influenza virus intranasally into healthy young adult male controls produced infection and communicability in all susceptible subjects.[211]

Pathogenicity

Clearly, this agent that produces epidemics nearly annually and pandemics every few decades is quite pathogenic. Local epidemics have attack rates as high as 50% in some settings.[48] The 1918 pandemic strain infected 280/1000 in the United States.[210] Though immunogenic, influenza A remains pathogenic year after year because of antigenic drift (especially) and antigenic shift (occasionally), requiring constant reformulation of the vaccine to help prevent influenza morbidity and mortality.[214]

Virulence

The pandemic strain in 1918 exacted half of its excess mortality from adults ages 20–40 years and killed 675,000 Americans, lowering the life expectancy by about 10 years during the epidemic.[15] Influenza kills 36,000 per year in the United States, on average.[216] A million excess deaths globally each year speaks at least somewhat to the virulence of influenza A.[48]

Reservoirs

It is established that the 1918 pandemic influenza strain entered both swine and humans directly, most likely from an avian source.[15,218] Humans are the main reservoir for influenza strains for which they are susceptible,[48] but knowledge of the interaction among avian, swine, and human hosts and the manner in which each serves as a reservoir and potential source of novel strains is critical.

Transmission

Airborne transmission of influenza A occurs through large particle droplets over distances less than a meter. Coughing and sneezing in crowded indoor areas facilitate transmission in winter months in temperate regions. Direct contact with droplet-contaminated surfaces also allows transmission.[46,48,216] When new influenza A subtypes develop, whether through point mutation or reassortment with avian proteins, they are quickly transmitted around the globe.[48]

Incubation and Period of Communicability

Influenza A incubates for about 2 days.[46,48] When volunteers were inoculated experimentally, viral titers peaked in the second day.[211] Communicability is for about 3 days after illness onset in adults, and can last twice as long in children.[48] Additionally, the infection may remain communicable for months in the immunocompromised.[46]

Susceptibility

The relationship of antigenic drift and shift to susceptibility has already been described in some detail. These factors are critical, because they keep susceptibility high among populations. Previous exposure to influenza produces immunity to that strain, but only limited immunity to other strains, depending on their similarity. The situation is obviously more critical when novel subtypes emerge, most likely with successful incorporation of HA or NA avian proteins. In these instances, there may be no immunity to these strains—and if they are efficiently transmitted and virulent, a pandemic will ensue.[46]

Population-Level Behavioral Factors Impacting Distribution

A few modern factors that influence the epidemiology of influenza A will be discussed here. One factor is industrial poultry farming. The consolidation of thousands or millions of birds in industrial settings has allowed novel strains to flourish—all transmission to humans of avian strains has occurred here. Millions of birds have died or been culled due to the spread of these avian strains in industrial settings.[89,132,213,219] Another factor is rapid transportation—influenza A strains can circle the globe in months.[48] Air travel may play a meaningful role in the spread of influenza A infection, and cities with international airports should expect to experience pandemic or epidemic strains from global sources sooner than other areas.[220,221] Last, there is concern about resistance. It has already been noted that influenza has displayed some resistance to antivirals in humans. Of additional concern is the appropriateness of vaccination of industrial poultry. China began the vaccination of its poultry with an inactivated H5N1 vaccine, which some feel is part of the present challenge.[222]

Prevention and Control

The annual threat of epidemics and the periodic threat of pandemics are both quite real; measures must be undertaken to control the transmission, morbidity, and mortality of influenza A. Control occurs through vaccination—the CDC has detailed recommendations relative to influenza vaccination.[46] In times of pandemic, the vaccine may be restricted to high-risk groups and health care

providers.[14] Control occurs through protection of health care workers, who need to use appropriate measures to prevent infection, particularly with novel or pandemic strains.[89,132] Control also occurs through surveillance for epidemics, as well as for novel strains, which are considered a notifiable disease.[50] Syndromic surveillance systems also serve the useful purpose of documenting unusual or epidemic upswings in influenza-like symptoms, which may herald an outbreak.[217]

Summary: Putting It All Together

This section has hopefully drawn on all of the elements of this chapter to describe the perpetually emerging and re-emerging infectious disease of influenza A and to bring alive the public health and epidemiologic interest in infectious disease. This section has demonstrated that the characteristics of the influenza virus (especially antigenic drift and shift); the receptors in avian species, swine, and humans permitting coinfection; human behaviors impacting spread of the virus (such as industrial poultry farming increasing transmission, and using chemoprophylaxis and vaccination to control it); and other factors have interacted to create the present distribution of influenza A, including epidemics and the threat of inevitable pandemic.

CONCLUSION

This chapter began with a litany of emerging infectious diseases: HIV/AIDS, Lyme disease, *E. coli* O157, hepatitis C, and SARS. This chapter has demonstrated that organism and human factors—including behavioral factors—have interacted to explain the distribution of disease. Modern tools allowed successful combat against infectious disease through much of the 20th century, but emerging infectious disease, bioterrorism, pandemic fears, health care–acquired infections, and re-emerging and resistant infectious organisms continue to be a real threat in the 21st century. There remains reason for optimism—smallpox has been eradicated, and polio and guinea worm are on the way. Vaccines have been developed for many infectious diseases, including some that cause cancer (HPV), and save millions of lives every year. Retrovirals have allowed people infected with HIV and hepatitis to continue leading normal lives. Yet complacence from funders and policy makers as well as practitioners and the public have allowed diseases such as tuberculosis to re-emerge resistant to multiple antibiotics.

Antibiotic resistance, health care–acquired infection, pandemic influenza, emerging infectious diseases, and bioterrorism are five of the great public health challenges that face humanity in the 21st century. Chiropractors should understand the importance of these themes, become informed using credible sources, and enter the public health conversation. This chapter has provided a (far from exhaustive) overview of many of these issues, and provided encouragement and some information to assist chiropractors as they join the public health effort to improve the health of communities and populations related to infectious disease.

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CHAPTER 9

CHAPTER OUTLINE

Prevention of Chronic Diseases

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INTRODUCTION

The most common chronic diseases in the United States are cardiovascular disease, cancer, and diabetes, leading to approximately $700 billion in annual direct and indirect costs[1] and approximately two thirds of all deaths (see **Table 9-1**).[2] It is clear that these diseases disproportionately affect the older population, and as the U.S. population ages, the impact of chronic diseases looms large. The U.S. per capita health care costs due to aging are projected to increase 0.3% annually,[3] with the greatest impact on per capita costs for chronic diseases that affect older Americans.[4] By the year 2040, Medicare costs for the oldest old are expected to increase six-fold.[5]

Table 9-1 Leading Causes of Death: United States, 2003–2004 (male and female)

Diseases of the heart
Malignant neoplasms
Cerebrovascular diseases
Chronic lower respiratory diseases
Unintentional injuries
Diabetes mellitus
Alzheimer's disease
Influenza and pneumonia
Nephritis, nephritic syndrome, and nephrosis
Septicemia

Source: National Vital Statistics Reports. 2007;56(5):1–96.

As the U.S. population continues to age, the physical and financial burden of chronic diseases will continue to get heavier, and health care professionals will need to play a more active role in prevention efforts. Chiropractors, who are especially known for their holistic approach, will need to strengthen their stand on screening and prevention and dedicate the time and effort needed to bring their patients closer to a healthy lifestyle (see **Table 9-2**). As stated by Hardy, "Imagine what could be done if a real national commitment were made to provide the resources necessary to truly address the challenges and opportunities of an aging population and the risk factors attendant to chronic diseases."[6]

Three modifiable and inter-related factors that aid in prevention of chronic diseases are physical activity, reduction in obesity, and diet modification. Physical activity both prevents and helps treat many diseases, including hypertension, diabetes, elevated cholesterol, obesity, colon cancer, breast cancer, osteoporosis, gall bladder disease, depression, and anxiety.[7–9] In developed countries, physical inactivity is associated with considerable economic burden, with 1.5% to 3.0% of total direct health care costs being accounted for by physical inactivity.[10] Even modest increases in activity levels could result

Table 9-2 Recommended Screening Tests for U.S. Adults

Recommendation	Males	Females	Comments
Abdominal aortic aneurysm	×		One-time screening by ultrasonography in men ages 65–75 who have ever smoked.
Alcohol misuse	×	×	
Breast cancer		×	Mammography every 1–2 years for women 40 +.
Breast and ovarian cancer susceptibility, genetic risk assessment and BRCA mutation testing		×	Refer women whose family history is associated with an increased risk for mutations in BRCA1 or BRCA2 genes for genetic counseling and evaluation for BRCA testing.
Cervical cancer		×	Women ages 21–65 who have been sexually active and have a cervix.
Chlamydial infection		×	Sexually active women < 25; other asymptomatic women at increased risk for infection.
Colorectal cancer	×	×	Adults 50 +.
Depression	×	×	In clinical practices with systems to assure accurate diagnoses, effective treatment, and follow-up.
Diabetes mellitus	×	×	Adults with hypertension or hyperlipidemia.
Diet, behavioral counseling	×	×	Adults with hyperlipidemia and other known risk factors for cardiovascular and diet-related chronic disease.
Gonorrhea		×	Sexually active women.
High blood pressure	×	×	
HIV	×	×	Adults at increased risk for HIV infection; all pregnant women.
Lipid disorders	×	×	Men 35 +; women 45 +.
Obesity	×	×	
Osteoporosis (postmenopausal women)		×	Women 65 +.
Syphilis infection	×	×	Persons at increased risk; pregnant women.
Tobacco use	×	×	
Tobacco-caused disease	×	×	

Source: Adapted from U.S. Preventive Services Task Force. 2008. *The Guide to Clinical Preventive Services.*

in substantial cost savings.[11] One research article suggests that if the current physical activity guidelines were followed, approximately one third of deaths related to coronary heart disease; one quarter of deaths related to stroke and osteoporosis; 20% of deaths related to colon cancer, hypertension, and type 2 diabetes; and 14% of deaths related to breast cancer could be prevented.[7]

There are many opinions on the best type and amount of exercise, though. Most recently, the Centers for Disease Control and Prevention collaborated with the American College of Sports Medicine to review the pertinent physiologic, epidemiologic, and clinical evidence on the types and amounts of physical activity for health promotion and disease prevention. The conclusion was that "every U.S. adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week."[12] This recommendation rarely is followed, yet should be a goal for all Americans in an effort to prevent and possibly treat debilitating and life-threatening chronic diseases.

A factor related to a lack of physical activity is obesity. Obesity is defined in many ways, such as through body weight, body mass index (BMI), waist circumference, waist-to-hip ratio, percentage of body fat, and percentage of trunk fat; however, scientists continue to debate the most valid method.[13–17] Most recently, the location of fat deposition has been viewed as the main factor that governs complications due to obesity,[18] with central adiposity leading to metabolic conditions such as atherosclerosis and type 2 diabetes.[19] Other disorders correlated with an increase in obesity are coronary heart disease, hypertension, arthritis, and cancer.[18] Even with new information about the associated risks, overweight and obesity prevalence have increased steadily, and, at the present rate of

increase, by 2048 all U.S. adults are predicted to be overweight or obese.[20] Fortunately, weight loss reduces the morbidity and mortality risks. In a recent study, gastric bypass surgery significantly reduced long-term total mortality, particularly deaths from diabetes, heart disease, and cancer.[21] Gastric bypass is an extreme treatment approach and is performed on only a small percentage of obese patients; however, it is interesting to note that reduction of obesity had such a significant effect on the three major chronic diseases affecting the U.S. population. Continued efforts in weight reduction through more conservative means such as diet modification and increase in exercise would have the same effect.

The final common thread in the prevention and treatment of chronic disease is diet. Diets that are high in salt, total fat, and saturated fat and low in fiber, fruits, and vegetables are central to the development of heart disease, cancer, and type 2 diabetes.[22,23] Further evidence demonstrates that a diet with a high glycemic index adversely impacts metabolism and appetite control regulation, and leads to a substantially greater risk of weight gain, type 2 diabetes, cardiovascular disease, and certain cancers.[24] In other words, poor diet leads to negative health consequences.

Poor diet, lack of exercise, and obesity are all *modifiable risk factors* for major chronic diseases such as cardiovascular disease, diabetes, and cancer. The purpose of this chapter is to define the modifiable risk factors for these three major diseases in an effort to encourage the chiropractic profession to get involved in programs in risk factor modification.

HEART DISEASE

Heart disease, also known as cardiovascular disease, typically includes coronary artery disease, hypertension, heart attack, and stroke. In 2006, heart disease cost the U.S. public $142.5 to $431.8 billion, including health care services, medications, and lost productivity.[25–28] Approximately one in three U.S. adults currently has heart disease, with a lifetime risk of two in three males and more than one in two females.[27] However, even though women have a lower risk of acquiring heart disease, every year more women than men die from this cause.[28]

In every year since 1900 (except 1918), heart disease accounted for more deaths than any other cause of death in the United States.[27] Because heart disease is such a serious public health issue, the search for risk factors has continued as a major focus in health care research. In the 1940s, investigators began studying the potential risk factors for heart disease in people who lived in Framingham, Massachusetts. The Framingham Heart Study continues today with three generations of subjects enrolled and well over 100 scientific publications on risk factors for heart disease. Some research discoveries have concluded that approximately 37% of adults in the United States report having two or more risk factors for heart disease including high blood pressure, high cholesterol, diabetes, smoking, physical inactivity, and obesity,[29] and 90% of coronary heart disease patients have prior exposure to at least one of these risk factors.[30] When four or more of these risk factors were present in middle age, fewer than 5% of men and approximately 15% of women survived to age 85.[27] An alarming increase in heart disease risk factors in the younger generations fuel the current cardiovascular epidemic that will continue for years to come,[27] leading to further increases in health care costs and personal suffering.

However, there is good news. After only one year in a study on comprehensive lifestyle changes, including a low-fat vegetarian diet, stopping smoking, stress management training, and moderate exercise, even severe coronary atherosclerosis regressed by as much as 82%, without use of lipid-lowering drugs.[31] Even though some heart disease risk factors cannot be modified, such as age[32–36] or genetic predisposition,[37,38] progression of heart disease can be reduced. The following are behaviors associated with reduction in heart disease, and should be a focus when discussing prevention with patients:

- *Reduce blood pressure:* Prevention and control of hypertension leads to reduction in overall heart disease.[39–46] Regular exercise, a low salt diet,[47,48] and relaxation[49] are possible conservative methods of blood pressure control. In one study, upper cervical manipulation was associated with marked and sustained reductions in blood pressure similar to the use of two-drug combination therapy.[50] Regular blood pressure screenings and education on hypertension prevention are important methods to prevent more severe heart disorders.
- *Reduce cholesterol levels:* Abnormal blood lipids are significantly correlated with the risk of heart disease, with high high-density lipoprotein (HDL) levels leading to a lower risk and high low-density lipoprotein (LDL) and triglyceride levels leading to a higher risk.[51–63] Clinicians should discuss possible solutions to cholesterol abnormalities, such as through diet modification or an increase in aerobic exercise.

- *Control diabetes:* People are at a greater risk of premature heart disease when they have insulin resistance, a disorder where various tissues are resistant to normal levels of plasma insulin.[64–66] Likewise, prevention and control of diabetes leads to a reduction in the morbidity and mortality of people with heart disease.[62,67–76] The best methods for prevention and control of diabetes appear to be diet and exercise.[77,78] In one study, the incidence of diabetes was reduced by 37% with diet and exercise alone,[77] potentially leading to an associated reduction in risk of heart disease.
- *Quit smoking:* Reduction or cessation of smoking also lowers the incidence and progression of heart disease.[56,79–89] However, difficulty in smoking cessation is commonly experienced; therefore, numerous methods are recommended including nicotine replacement therapy,[91] exercise,[91] counseling,[92] and prescription antidepressants.[93] Alternate methods that may influence some individuals to quit smoking include hypnotherapy[94] and acupuncture.[95]
- *Increase physical activity:* There is now definitive evidence that physical activity continued throughout life is able to reduce cardiovascular morbidity and mortality,[9,96–101] with the most physically active people generally demonstrating rates half those of the most sedentary group.[9] The Centers for Disease Control and Prevention and the American College of Sports Medicine recommend 30 minutes or more of moderate intensity physical activity such as brisk walking on most, and preferably all, days of the week.[12] However, it is recommended that objective measures of fitness rather than the relatively imprecise assessments of self-reported physical activity are more likely to demonstrate a strong relationship to decreased cardiac events.[9,100] In other words, it is better to objectively measure a patient's fitness level rather than ask them how much exercise they complete when discussing their risk of heart disease.
- *Maintain a healthy weight:* Obesity is an independent risk factor for heart disease.[102–104] Exercise programs are a beneficial way for children and adults to maintain and/or obtain a healthy weight,[105,106] as are low fat diets.[107]
- *Eat well:* Another factor in the prevention of heart disease is a healthy diet that limits carbohydrates and processed sugars and is low in saturated and trans fats.[108] Vegetarians have a lower risk of dying from ischemic heart disease than nonvegetarians.[109] The Mediterranean diet is one that includes abundant fruits and vegetables, grains, nuts, olive oil, dairy products (principally cheese and yogurt), fish, poultry, and small amounts of eggs, red meat, and wine.[110,111] Among individuals ages 70 to 90 years, adherence to a Mediterranean-style diet and greater physical activity are associated with 65% to 73% lower rates of all-cause mortality, as well as mortality due to heart disease and cancer.[112] Dietary supplementation may also be cardioprotective, such as with omega-3 fatty acids, which have been shown to reduce major coronary events by 18%,[113] and with vitamin K, which has been shown to inhibit and reverse arterial calcification.[114–116]
- *Keep inflammation in check:* A pro-inflammatory physical state is thought to increase the incidence and severity of cardiovascular disease, possibly through high levels of blood proteins,[117–119] hyperviscosity (thickening) of the blood,[120] and increasing arterial stiffness.[121] C-reactive protein[122] and homocysteine[123–126] levels are a measure of inflammation and are positively associated with future cardiac events. An 81 mg/day dose of aspirin is most commonly suggested to reduce the incidence of cardiovascular events, presumably through anti-platelet activity.[127–129] Prevention and elimination of infections, including *H. pylori* infection,[130] *C. pneumoniae* infection,[131] and periodontal disease, are also suggested to reduce inflammation and therefore the risk of heart disease.[132] However, evidence available to date does not demonstrate an overall benefit of antibiotic therapy in reducing mortality or cardiovascular events in patients with coronary artery disease.[133]

DIABETES

The incidence of type 2 diabetes doubled in the past 30 years in middle-aged U.S. adults.[134] The current estimated lifetime risk of developing diabetes in the United States is 32.8% for males and 38.5% for females,[135] with approximately 6.9% of diabetics going undiagnosed.[136] With one third of Americans eventually being diagnosed with diabetes, it is not surprising that the annual direct expenditures for patients with diabetes are estimated to be more than $82 billion.[137]

Even though some diabetes risk factors are *nonmodifiable*, such as age, family history, and certain racial categorizations such as Hispanic and African American, many lifestyle characteristics are modifiable, including the following:

- *Maintain a healthy lifestyle:* A 43–58% risk reduction in incidence of diabetes is related to lifestyle interventions such as achieving weight loss goals, reduced intake of total and saturated fat, increased intake of dietary fiber, and increased physical activity.[138,139] Changes in lifestyle can be inexpensive and easy to implement; however, sustainability of these changes can be difficult. A strong relationship between clinician and patient may be necessary for promotion and maintenance of a healthy lifestyle.
- *Maintain a healthy weight:* Weight reduction has been shown to improve insulin sensitivity and regulation of blood sugar in both overweight adults[140] and children,[141] with a body mass index (BMI) of greater than 25 being associated with a higher risk of type 2 diabetes. Dietary weight reduction is difficult for some people, and in such cases bariatric surgery has been shown to successfully reduce diabetes risk.[142] Along with obesity, a new study has shown that a person's body shape may also lead to some clues about diabetic risk. The distribution of fat leading a person to an "apple" shape (larger around the waist) is associated with a higher risk of diabetes than a "pear" shape person (smaller waist than hips).[143] Therefore, it is important to assess both weight and body shape when discussing diabetes risk with patients.
- *Eat a low-fat, nonprocessed diet:* Western diets, such as diets high in red or processed meat, high-fat dairy products, and candy, are associated with increased risk of diabetes,[144,145] particularly when paired with low levels of exercise. Dietary suggestions for diabetes prevention might therefore include a diet high in fruits, vegetables, fish, whole grains, nuts, low-fat dairy products, and poultry, and low in high-caloric and processed foods such as refined grains, processed meats, packaged meals, carbonated sugar beverages, and candy.
- *Quit smoking or never start:* Several prospective studies have demonstrated that cigarette smoking significantly increases diabetes risk. In one recent meta-analysis, the risk of diabetes was determined to be approximately 61% higher in heavy smokers (more than or equal to one pack per day) and 29% higher in light smokers (less than one pack per day) than in nonsmokers.[146] The duration of smoking or increased pack-years appears to further increase the risk.[147] Fortunately, there are data demonstrating a reduction in the risk of diabetes with smoking cessation.[146]

CANCER

Cancer is now a major cause of mortality throughout the world; in the developed world, it is generally exceeded only by cardiovascular diseases. As developing countries become urbanized, patterns of cancer, including those most strongly associated with diet, tend to shift towards those of economically developed countries. Between 2000 and 2020, the total number of cases of cancer in the developing world is predicted to increase by 73% and, in the developed world, to increase by 29%, largely as a result of an increase in the number of older people where risk is highest.[148]

When deaths are aggregated by age, cancer has surpassed heart disease as the leading cause of death for persons younger than 85 since 1999.[149] In 2002, there were 10.9 million new cases of cancer worldwide, 6.7 million deaths, and 24.6 million people alive with cancer within 3 years of diagnosis.[150] The most commonly diagnosed cancers were lung (1.35 million), breast (1.15 million), and colorectal (1 million).[150] There are striking variations in the risk of different cancers by geographic area, with most of the international variation due to exposure to known or suspected risk factors related to lifestyle or environment.[150] Cancer rates also differ by gender, as seen in **Table 9-3**.

Progress in reducing the burden of suffering and death from cancer can be accelerated by applying existing cancer control knowledge across all segments of the population,[149] and focusing on risk factor prevention (see **Table 9-4**). Advances in the prevention, early detection, and treatment of cancer have resulted in an almost 14% decrease in the death rates from all cancers combined from 1991 to 2004 in the overall U.S. population.[151] Remarkable declines in mortality have occurred for the top three causes of cancer death in men (lung, colorectal, and prostate cancer) and two of the top three cancers in women (breast and colorectal cancer).[151] However, not all segments of the population have benefited equally from this progress, and evidence suggests that some of these differences are related to lack of access to health care.[151]

Table 9-3 Lifetime Risk of Developing or Dying from Cancer

	Female		Male	
Site	Developing	Dying	Developing	Dying
All sites	1 in 3	1 in 5	1 in 2	1 in 4
Bladder	1 in 88	1 in 313	1 in 28	1 in 132
Breast	1 in 8	1 in 34	1 in 833	1 in 3333
Colon and rectum	1 in 19	1 in 46	1 in 17	1 in 43
Leukemia	1 in 95	1 in 141	1 in 67	1 in 103
Lung and bronchus	1 in 16	1 in 20	1 in 13	1 in 14
Melanoma of the skin	1 in 73	1 in 500	1 in 49	1 in 278
Non-Hodgkin's lymphoma	1 in 55	1 in 127	1 in 47	1 in 108
Prostate	—	—	1 in 6	1 in 34
Uterine cervix	1 in 137	1 in 400	—	—
Uterine corpus	1 in 40	1 in 196	—	—

Source: SEER Cancer Statistics Review 1975–2003, National Cancer Institute (Illinois Facts and Figures, 2006).

A considerable amount of evidence is available on cancer prevention. The following sections discuss risk reduction of lung, breast, colorectal, and prostate cancer.

Lung Cancer

Lung cancer is the most common cause of cancer-related death in men and the second most common in women, with an average 5-year survival rate of 15%.[152] The incidence of lung cancer was extremely low before the advent of cigarette smoking, and today the majority of cases of lung cancer are due to smoking; however, 10% to 20% of lung cancer cases occur in people who do not smoke.[153] Some of the possible factors unrelated to smoking include female gender, older age, family history, and genetics. However, lung cancer risk reduction is possible through modification of certain lifestyle factors.

- *Abstain from smoking:* In the United States, about 90% of lung cancer deaths in men and almost 80% of lung cancer deaths in women are due to smoking. People who smoke are 10 to 20 times more likely to get lung cancer or die from lung cancer than people who do not smoke. The longer a person smokes and the more cigarettes/cigars smoked each day, the more risk goes up.[154–156] People who quit smoking have about a 25% lower risk of lung cancer than if they had continued to smoke, but their risk continues to be higher than people who never smoked.[157] In order to prevent the more than

Table 9-4 Cancer Risk Factors

	Breast Cancer	Prostate Cancer	Lung Cancer	Colorectal Cancer
Nonmodifiable Risk Factors				
Gender	Female	Male	Female	
Advanced age	×	×		
Race	White	Black		Black
Genetics	×			×
Family history	×	×	×	×
Modifiable Risk Factors				
Obesity	×			×
Physical inactivity	×	×		×
Poor diet		×	×	×
Alcohol use	×		×	×
Smoking			×	×

4000 chemicals generated from burning of the tobacco plant from affecting the lung cells, abstain from smoking.[158]

- *Avoid second-hand smoke exposure:* In a review article on lifelong nonsmokers exposed to environmental smoke, the data from 37 previous studies were collapsed to determine that the risk of lung cancer is increased by 24% in nonsmokers who lived with a smoker.[159] The risk of lung cancer increased with both the duration of the second-hand smoke exposure and the number of cigarettes smoked by the spouse or roommate.[160] Avoiding second-hand smoke appears to significantly reduce the risk of lung cancer.
- *Avoid asbestos, radon, arsenic, tar soot, nickel, and some forms of silica and chromium:* There are many inhaled toxins at home and on the job that may increase the risk of lung cancer. Radon, a radioactive gas that you cannot see, smell, or taste, may be found in the home. Work in construction and chemical industries can lead to unknown exposure to asbestos, arsenic, and other substances. Occupational and environmental exposures to these known carcinogens increase the risk of lung cancer.[161,162] For many of these substances, the risk of getting lung cancer is even higher in those who also smoke.[154] Testing for toxins in the air is important if there is cause for concern. When testing is not available or possible, protective gear such as breathing masks may be the best method of prevention.
- *Limit alcohol intake:* The relationship between alcohol and lung cancer is difficult to measure due to the confounding factor of direct or environmental cigarette smoke. However, high consumption of beer and/or liquor appears to be associated with an increased risk of lung cancer, particularly in men, and modest wine consumption may be inversely associated with risk.[163] Avoidance of beer and liquor and ingestion of wine in moderation appears to be the best advice for prevention of lung cancer.
- *Eat a balanced diet:* Diet and dietary supplementation may play a role in lung cancer prevention. However, studies on vitamins A, C, and E; beta carotene; folate; and multivitamins have demonstrated conflicting results.[164–166] Epidemiologic studies on diets rich in fruits and vegetables demonstrate an overall cancer risk reduction, particularly significant for prevention of lung cancer.[167] Diets low in fat and cholesterol have also been shown to reduce lung cancer risk.[168,169] Based on this information, the dietary recommendation for prevention of lung cancer is to eat a balanced diet that includes plenty of fruits and vegetables and is low in fats and cholesterol.

Breast Cancer

Breast cancer is the most common cancer diagnosed among U.S. women, and is second only to lung cancer as a cause of cancer deaths in women.[170] According to the American Cancer Society, the incidence of breast cancer has increased from about 1 in 20 in 1940 to 1 in 8 in 2005. There are many suggestions for why such an increase has occurred, such as higher exposure to risk factors and better diagnostic equipment, but approximately 60% of all women with breast cancer still have no known risk factors.[171]

Some of the most commonly known risk factors are nonmodifiable. For example, breast cancer is 100 times more common among women than men due to the presence of more breast tissue and the growth-promoting effects of the female hormones estrogen and progesterone. Breast cancer incidence also increases with age, with about 80% of breast cancers occurring in women older than age 50.

Between 10% and 25% of breast cancers are thought to be inherited.[172] Defects in one of several genes, especially BRCA1 and BRCA2, increase the risk of developing breast, ovarian, and colon cancers.[172,173] Normally, these genes help to prevent cancer by making proteins that keep cells from growing abnormally; however, inheriting a mutated copy of either gene from a parent increases the risk for breast cancer. Although BRCA mutations are found most often in Jewish women of Ashkenazi/Eastern European origin,[174] they can occur in any racial or ethnic group.

Even though the majority of breast cancer diagnoses have no known risk factors, there are some methods for prevention through possible lifestyle modifications. However, not all modifications are possible or practical for all women.

- *Minimize use of oral contraceptives:* Use of birth control pills is associated with an increased risk of breast cancer in premenopausal women,[175] particularly if oral contraception is used for 4 or more years before their first full-term pregnancy.[176] Risk levels return to normal within 5 years after discontinuing use.[177]

- *Minimize use of postmenopausal hormone replacement therapy (HRT), especially combined estrogen and progestin therapy:* Use of HRT increases the risk of new and fatal breast cancer,[178] especially when using a combination of estrogen and progestin[179,180] and with increasing duration of use.[181] In addition, treatment with both estrogen and progesterone can make malignant tumors harder to detect on mammograms, leading to cancers that are diagnosed at more advanced stages and that are harder to treat. Using estrogen alone hasn't been shown to increase breast cancer risk in postmenopausal women.
- *Maintain a healthy weight:* Overweight or obesity, especially when occurring after menopause, increases women's risk of breast cancer.[182–187] Before menopause, ovaries produce most of the estrogen, and fat tissue produces a small amount of estrogen. After menopause, once the ovaries stop making estrogen, most of a woman's estrogen comes from fat tissue. Having more fat tissue after menopause can increase your estrogen levels and thereby increase your likelihood of developing breast cancer.
- *Exercise regularly:* Physical activity reduces breast cancer risk.[188] As little as 1.25 to 2.5 hours per week of brisk walking can reduce a woman's risk of breast cancer by 18%, and walking 10 hours a week demonstrated a slightly greater reduction.[189] The American Cancer Society recommends 45 to 60 minutes of intentional physical activity 5 or more days a week.[190]
- *Minimize alcohol intake:* Breast cancer risk increases with the amount of alcohol consumed.[190–192] Compared with nondrinkers, women who consume one alcoholic drink a day have a very small increase in risk. Those who have two to five drinks daily have about $1^1/_2$ times the risk of women who drink no alcohol.
- *Have children early in life:* Women who have had no children or who had their first child after age 30 have a slightly higher breast cancer risk. Having multiple pregnancies and becoming pregnant at an early age reduce breast cancer risk.[193,194] Although it is not entirely clear why, an early first pregnancy may protect breast tissue from developing genetic mutations that result from estrogen exposure.[195,196]
- *Breastfeed:* Some evidence suggests breastfeeding, especially if continued for up to 2 years, slightly lowers breast cancer risk.[193,197] The possible explanation is that breastfeeding reduces the total number of lifetime menstrual cycles; therefore, the reduced risk is similar to women who start menstruating at a later age or undergo an early menopause.

Colorectal Cancer

Colorectal cancer is the second-leading cause of cancer-related deaths in the United States among cancers that affect both men and women. The risk of colorectal cancer increases with age, with more than 90% of cases being diagnosed in individuals older than 50. Increased colorectal cancer incidence and mortality in African Americans can be attributed to health care barriers such as lower screening rates, less use of diagnostic testing, decreased access to health care, cultural beliefs, and lack of education regarding health care practices and preventable disease.[198] Inflammatory bowel disease, family history, and genetics[199] all play a factor in colorectal cancer risk. However, several modifiable factors are beneficial in prevention of colorectal cancer.

- *Get colonoscopies and have polyps removed:* Regular colorectal cancer screening is one of the best ways to help prevent colorectal cancer. The main reason that screening leads to cancer prevention is that removal of polyps in the colon results in a lower incidence of colorectal cancer.[200,201] Likewise, early detection of colorectal cancer leads to early treatment and reduced mortality.
- *Maintain a healthy weight:* Obesity is associated with colorectal cancer, with stronger associations in men than in women. In a recent meta-analysis of prospective studies, just a five-unit increase in BMI related to a 30% increased risk of colon cancer in men and a 12% increased risk in women.[202] Rectal cancer was also associated with a higher BMI in men, but a significant association was not demonstrated in women.[202] Waist circumference and waist-to-hip ratio may be better risk markers for colon cancer, with a 10-cm increase in waist circumference leading to a 43% increase in risk and a 0.1-unit increase in waist-to-hip ratio leading to a 20–40% increase in risk.[202] The important factor in these data is that maintaining a healthy weight significantly reduces the likelihood of developing colorectal cancer, and treatment for obesity should be a main focus in clinical practice.

- *Eat a healthy diet:* Diet patterns and supplementation are significantly associated with the risk of colorectal cancer. A diet high in red and processed meat leads to a higher risk of colorectal cancer, whereas consumption of poultry and fish appears to be inversely associated.[203] Sufficient fiber intake reduces the risk of colorectal cancer,[204,205] although evidence on fruits and vegetables remains weak and inconclusive.[206] Finally, dietary supplementation with calcium and vitamin D appears to be beneficial in reduction of polyp formation and therefore possibly reduces the colorectal cancer risk.[207–209] All food and dietary supplements travel through the colon and rectum, making it biologically plausible that there is a direct correlation to cancer formation. Counseling patients on proper dietary habits may lead to prevention of polyp and cancer formation.

Prostate Cancer

Prostate cancer is the most common cancer among U.S. men.[170] Autopsy studies show that out of every 10 men age 80 or over who died from any cause, as many as 7 to 9 of them also had prostate cancer, but neither they nor their doctors knew they had it. In men younger than 50, one in three has histological evidence of prostate cancer.[210]

High levels of circulating testosterone are associated with increased risks of prostate cancer[211]; however, the strongest risk factor for prostate cancer is age, with more than 65% of all prostate cancer cases diagnosed in men 65 years of age or older. African American men and Jamaican men of African descent are at the highest risk for prostate cancer diagnosis. Recent genetic studies suggest that strong familial predisposition may be responsible for 5% to 10% of prostate cancers. Several modifiable factors appear to aid in the prevention of prostate cancer.

- *Eat a low fat diet:* Studies suggest that a diet high in saturated fat, red meat, and high fat dairy products may increase the risk of prostate cancer.[212,213]
- *Eat a variety of fruits and vegetables:* Plant-based phytoestrogens, which are thought to have anticarcinogenic properties, appear to be protective for prostate cancer.[214,215] Vegetables presumed protective include tomatoes, cruciferous vegetables, soy, beans, and other legumes. Dietary supplementation of vitamin E, selenium, beta carotene, and lycopene may have similar results.
- *Reduce supplementation of calcium:* High calcium intake is associated with increased risk for more aggressive types of prostate cancer, particularly when calcium was ingested as a dietary supplement.[216,217]
- *Maintain a healthy weight:* No consistent relationship has been demonstrated between prostate cancer risk and obesity; however, recent data suggest that being overweight is associated with worse prognosis after diagnosis and treatment among men with prostate cancer.[218–220] Body size relatively early in life may influence men's later rate of prostate cancer.[220]
- *Exercise:* No studies have demonstrated a reduced risk of prostate cancer with exercise. However, some studies have found that high levels of physical activity, particularly in older men, may lower the risk of advanced prostate cancer.
- *Drink green tea:* Green tea contains several components including catechins, a category of polyphenols that have chemopreventive properties. Although evidence from epidemiologic studies is not comprehensive, it is strengthened by animal and in vitro evidence suggesting that consumption of tea is associated with decreased risk or progression of prostate cancer.[221] As a secondary observation, drinking green tea also reduced lower urinary tract symptoms, suggesting that the compounds in green tea might also be of help for treating the symptoms of benign prostatic hyperplasia.[222]
- *Control infection and inflammation of the prostate:* Prostatitis, inflammation of the prostate gland, may be linked to an increased risk of prostate cancer, although the findings are inconsistent. Sexually transmitted infections might also increase the risk of prostate cancer, but no firm conclusions have been reached.

CONCLUSION

The focus of this chapter was on the prevention of heart disease, diabetes, and cancer, which are three of the most prevalent diseases in the United States. However, it is important for the clinician to recognize that a large segment of people in the United States and other developed countries have *comorbid* chronic conditions.[224,225] In the United States, multiple chronic conditions affect approximately 21% of the general population and 62% of

people over 65.[223] In addition, the prevalence of comorbidity is greater in women than in men, which is mainly attributed to greater female life expectancy.[225] Patients with comorbid conditions have different clinical needs, increased disability, and more rapid declines than do people with solitary conditions,[226–228] leading to more complex treatment parameters, the possibility of side effects, and potential for death.

It is not surprising that so many people develop comorbid conditions considering the overlap in risk factors for chronic diseases, most particularly the lifestyle or behavioral risk factors. In particular, cigarette smoking, excessive alcohol consumption, lack of physical activity, and poor diet contribute significantly to preventable chronic disease morbidity and mortality.[229–231] As the clinician seeks to reduce the burden of chronic disease on her or his patients, understanding the potential benefits of risk reduction on more than one disease through recommendation of a healthy lifestyle is of utmost importance.

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CHAPTER
10

CHAPTER OUTLINE

Physical Fitness

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Regular physical activity throughout life is necessary for maintaining a healthy body, enhancing psychological well-being, and preventing premature death.[1] Fitness through physical activity and exercise is critically important for the health and well-being of people of all ages.[2] Regular physical activity is associated with lower death rates for adults of any age, even when only moderate levels of physical activity are performed.[1] Studies have shown that virtually all individuals can benefit from regular physical activity, whether they participate in vigorous exercise or some type of moderate health-enhancing physical activity.[3] Regular physical activity has been shown to reduce the morbidity and mortality from many chronic diseases. Millions of people suffer from chronic illnesses that can be prevented or improved through regular physical activity. Regular physical activity improves health in the following ways:

- Reduces the risk of dying from heart disease and other conditions
- Reduces the risk of developing high blood pressure
- Reduces blood pressure in people who already have hypertension
- Reduces the risk of developing colon and breast cancer
- Helps maintain a healthy weight
- Helps build and maintain healthy bones, muscles, and joints
- Helps older adults to become stronger and better able to move about without falling
- Reduces feelings of depression and anxiety

- Promotes psychological well-being
- Reduces the risk for Alzheimer's disease
- Promotes retention of cerebral gray and white matter

INACTIVITY AS A MAJOR RISK FACTOR

Physical inactivity is a major risk factor for cardiovascular disease. In the United States alone it is estimated that over 12.6 million people have coronary heart disease and 1.1 million people suffer from a heart attack in a given year. This number can be dramatically reduced through physical activity.[4]

An epidemic of diabetes affected an estimated 20.8 million people in 2005, which represents 7% of the population.[5] This is a large increase from an estimated 17 million cases in 2002.[6] Associated with obesity and physical inactivity, type 2 diabetes is found in 90–95% of those with diabetes.[6] In addition, approximately 16 million people in the United States are estimated to be prediabetic with impaired glucose tolerance. Moderate physical activity, such as walking 2.5 hours each week, can significantly reduce the effects of diabetes.

Osteoporosis, the leading cause of over 300,000 hip fractures annually, is partially linked to a sedentary lifestyle. Postmenopausal females are more susceptible, but this is not just a disease of older females, with one third of osteoporotic hip fractures occurring in men.[7]

Nearly 50 million adults between the ages of 20 and 74, or 27% of the adult population, are obese (see **Figure 10-1**). Overall, more than 108 million adults or 61% of the adult population are either obese or overweight.[8] Associated with obesity and inactivity is hypertension, with approximately 50 million people suffering from high blood pressure.[4] Also linked to inactivity is colon cancer, with 107,000 Americans newly diagnosed with this condition each year.[9]

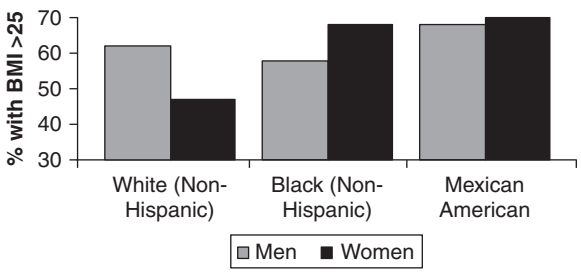

Figure 10-1 Age-adjusted prevalence of overweight or obesity in selected groups, 1988–1994.

Source: Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity, 2001.

Mental illness affects approximately 20% of the U.S. population during a given year.[1] Regular physical activity enhances psychological well-being and appears to reduce symptoms of depression and anxiety and improve mood.[1]

Despite the well-known benefits of physical activity, many adults and children lead relatively sedentary lifestyles. On average, people who are physically active outlive those who are sedentary.[1] A sedentary lifestyle is defined as engaging in no leisure-time physical activity (exercise, sports, or physically active hobbies) in a 2-week period.[2] At a minimum, adults 18 years of age or older should engage in moderate levels of physical activity for 30 minutes a day, 5 or more days per week.[1]

THE COST OF INACTIVITY

Physical activity is fundamental to preventing disease. There is a growing body of research quantifying physical inactivity as a serious and expensive public health problem. The costs associated with physical inactivity are borne by taxpayers, employers, and individuals.[10] In addition to improving the quality of life through increased physical activity, the astronomical cost to society in terms of lost productivity and ever-increasing health care costs can be mitigated by decreasing sedentary lifestyles.[11] These two types of costs run into billions of dollars annually. Adoption of a population-wide physical activity strategy can produce health care cost savings among most adult age groups.[12]

Health care costs for preventive, diagnostic, and treatment services related to chronic conditions can be dramatically reduced by a more physically active population. These costs include expenditures for physician visits, pharmaceuticals, ambulance services, rehabilitation services, and hospital and nursing home care.[2] The economic cost from work loss and decreased productivity from disability can be decreased with a reduction in chronic diseases. In addition, there are other costs associated with the value of future earnings lost because of premature death.[2]

The Medicare and Medicaid programs alone spend over $84 billion annually for five major chronic conditions: heart disease, depression, cancer, arthritis, and diabetes. These costs could be significantly decreased by increasing levels of physical fitness.[2] Medicare spent $10.4 billion on diabetes treatment and services in the year 2000. Medicare spending on heart disease treatment and services grew from $21.1 billion in 1992 to

$34.9 billion in 2000, with spending on depression treatment and services growing from $1.3 billion to $2.5 billion during the same period. Annual costs for cancer treatment and services more than doubled from 1992 to 2004. These estimates include only Medicare program payments for direct costs and do not include any indirect costs of the diseases that may be significant, including copayments and deductibles.[2]

In the long run, physical inactivity threatens to reverse the decades-long progress that has been made in reducing morbidity and mortality associated with many chronic conditions such as cardiovascular disease. A physically inactive population is both a medical and financial risk for many chronic diseases and conditions including heart disease, stroke, colon cancer, diabetes, obesity, osteoporosis, and depression.

DECREASING HEALTH CARE COSTS AND INCREASING PRODUCTIVITY

Regular physical activity helps prevent disease and promote health, so it is expected that it may actually decrease health care costs. A study conducted by the Centers for Disease Control and Prevention (CDC) found that physically active people had, on average, lower annual direct medical costs than inactive people. This study estimated that increasing regular moderate physical activity among the more than 88 million inactive Americans over the age of 15 years might reduce the annual national direct medical costs by as much as $76.6 billion in 2000 dollars. The researchers concluded that adoption of a population-wide physical activity strategy might produce health care cost savings among most adult age groups.[12]

It also has been estimated that workplace physical activity programs can reduce short-term sick leave by 6–32%, reduce health care costs by 20–55%, and increase productivity by 2–52%.[12] Both employees and employers can benefit from wellness programs that include physical fitness, stress management, smoking cessation, prenatal care, and nutrition.[13]

FIT FOR LIFE

Regular physical activity and exercise provide fitness that is critically important for the health and well-being of people of all ages. Research has demonstrated that virtually all individuals can benefit from regular physical activity, whether they participate in vigorous exercise or some type of moderate health-enhancing physical activity. Fitness is not just a concern for those in the prime of life. The significant increase in childhood and adolescent obesity draws attention to a crisis in public health. Even among frail and very old adults, mobility and functioning can be improved through physical activity. The prospective Canadian Study of Health and Aging indicated that participating in regular physical activity decreases risk for Alzheimer's disease, one of the most devastating disorders of elderly individuals.[14] Further, a recent study conducted at the University of Illinois Urbana campus revealed the exciting discovery that otherwise healthy elderly sedentary individuals who participated in a 6-month aerobic training program actually gained cerebral gray and white matter.[15]

THE HEALTH RISKS OF NOT MAINTAINING A HEALTHY WEIGHT

Epidemiological studies have demonstrated an increase in mortality associated with overweight and obesity. Over 300,000 deaths a years in the United States are associated with overweight and obesity.[16] Morbidity from obesity is thought to be as great as from poverty, smoking, or problem drinking.[17] Overweight and obesity are associated with and increased risk for developing various medical conditions including cardiovascular disease, certain cancers (endometrial, colon, postmenopausal breast, kidney, and esophageal)[18], high blood pressure, arthritis-related disabilities and type 2 diabetes. Health risks associated with obesity are outlined in **Table 10-1**.

Obesity in Children

Childhood obesity has dramatically increased during the past two decades.[8] The prevalence of overweight among children ages 6 to 11 has more than doubled, going from 7% in 1980 to 18.85% in 2004. The rate among adolescents ages 12 to 19 has more than tripled, increasing from 5% to 17.1%.[19] The growing incidence is alarming given the short- and long-term consequences associated with obesity.[18] This trend can be expected to increase expenditure of economic resources in the health care sector in addition to the decrease in overall health and well-being of the population.[20] As the prevalence of overweight and obesity increases in children and adolescents, type 2 diabetes, high blood lipids, and hypertension as well as early maturation and orthopedic problems are occurring with increased frequency. In addition, a common consequence of childhood overweight and obesity is psychosocial problems.[21]

Table 10-1 Health Risks Associated with Obesity

Obesity is associated with an increased risk of:	
• Premature death	• High blood cholesterol
• Type 2 diabetes	• Complications of pregnancy
• Heart disease	• Menstrual irregularities
• Stroke	• Hirsutism (presence of excess body and facial hair)
• Hypertension	• Stress incontinence (urine leakage caused by weak pelvic-floor muscles)
• Gallbladder disease	• Increased surgical risk
• Osteoarthritis (degeneration of cartilage and bone in joints)	• Psychological disorders such as depression
• Sleep apnea	• Psychological difficulties due to social stigmatization
• Asthma	
• Breathing problems	
• Cancer (endometrial, colon, kidney, esophageal, and postmenopausal breast cancer)	

Interventions for Preventing Obesity in Children

A Cochrane review that reported on studies that evaluated the outcomes of dietary and physical activity changes for the prevention of obesity in children showed a small but positive impact on body mass index (BMI). Nearly all of the studies included in this review that focused on combined dietary and physical activity approaches demonstrated some improvement.[22] The CDC recommends key strategies to prevent childhood obesity including BMI measurement in schools and assessment of school meal programs with offerings of nutritious choices. Physical activity guidelines include daily physical education classes and intramural programs for all grades, with active play and recess activities for younger students.[23]

Parents' responsibilities for preventing and reducing obesity in children and adolescents must include providing more nutritious meals with fewer calories and providing opportunities for more physical activity. Just as important is the limitation of passive leisure time, including hours spent in front of the television and playing video games. Although obesity-associated morbidities occur most frequently in adults, important consequences of excess weight as well as antecedents of adult disease occur in overweight children and adolescents. Overweight children and adolescents are more likely to become overweight or obese adults.

Obesity in Adults

As with children and adolescents, prevention of obesity in adults is dependent on regular physical activity along with a nutritious diet. In order to maintain a healthy weight, there must be a balance between calories consumed and calories expended through metabolic and physical activity. Although overweight and obesity are caused by many factors, in most individuals weight gain results from a combination of excess calorie consumption and inadequate physical activity. Even though a large portion of a person's caloric requirement is used for basal metabolism and processing food, an individual's various physical activities may account for as much as 15% to 40% of the calories burned each day.

Although vigorous exercise uses calories at a high rate, any physical activity burns calories. It is important for individuals who are currently at a healthy weight to strive to maintain it, because both modest and large weight gains are associated with significantly increased risk of disease. For example, a weight gain of 11 to 18 pounds increases a person's risk for developing type 2 diabetes twice that of individuals who have not gained weight. A weight gain of 44 pounds increases the risk of type 2 diabetes four times. A gain of 10 to 20 pounds increases the risk of coronary heart disease 1.25 times in women[24] and 1.6 times in men.[25] Overweight and obesity are also known to exacerbate many chronic conditions such as hypertension and elevated cholesterol.[26] Overweight and obese individuals also often suffer from social stigmatization, discrimination, and poor body image.

HEALTH BENEFITS OF SPECIFIC EXERCISES

Participation in physical activity during recreation and sports can promote social well-being, as well as good mental health, among people of all ages. Sports and

physical activity programs develop skills, self-discipline, leadership, and cooperation. They offer opportunities for socialization and benefit both physical and mental health.

Studies indicate that older individuals who remain active in sports and recreational activities have higher levels of fitness (aerobic power, strength, flexibility and functional capacity) than older individuals who are sedentary.[27] Many individuals enjoy participation in sporting and recreational activities and do not perceive them as being exercise, but rather as fun. Any sporting and/or recreational activity that increases heart rate will have aerobic benefits, burn calories, and increase circulation to vital organs such as the brain. Examples of recreational and/or sporting activities that promote fitness and vitality include hiking, soccer, basketball, running, swimming, flag football, golf, tennis, bowling, cross country and downhill skiing, volleyball, lacrosse, and paddling. Of course there are many more recreational/sports activities than could be listed here. The important thing with recreation and sports is for people to engage in something/anything regularly that they really enjoy. A sense of enjoyment will enhance and enrich the fitness experience. Participating in multiple sports or recreational activities provides variety and the added benefit of functional balance.

Some types of recreational activity have particular benefits, whereas others have inherent concerns. Swimming is especially beneficial for individuals with joint problems and lower extremity disorders affecting the feet, ankles, knees, and hips. Individuals use swimming very effectively when rehabilitating injuries in those areas and the spine. On the other hand, one-sided sports like golf place a great deal of repetitive strain on the spine and related structures. When participating in a unilateral sport like golf, it is important to stretch and utilize muscles that are not used in a balanced way while golfing. For example, before and after golfing, take a number of swings using the opposite hand with the opposite motion to balance your spine and activate unused muscles. This will help to prevent repetitive stress/strain injuries and postural imbalances. Similar practices can be adopted for other unilateral sports such as tennis.

Activities for Spinal Health Promotion and Straighten Up

Exercise, sports, and recreational activities have many benefits including enhancement of muscular strength, coordination, balance, and endurance. Engaging in more activity can also help to prevent spinal disability.[28] Conversely, obesity and sedentary lifestyles are positively correlated with increased back pain and disability.[29–31]

Studies indicate that spinal health is on the decline, even in children and adolescents.[32] Children and adolescents carry large book bags and sit in classrooms for long periods of time. More and more adults are sedentary, using computers at their work and for recreation. The Rancho Bernardo studies conducted by gerontologists at UCLA indicate that elderly individuals with poor stooped posture have increased mortality rates, more functional disabilities, and increased independent risk for osteoporotic fractures.[33,35] The health care costs associated with spine pain are extraordinary. Based on analysis of MEPS (Medical Expenditures Panel Survey), the United States Bone and Joint Decade estimates that approximately $193.9 billion were spent on spinal health interventions in 2004.[36] The United States simply cannot afford to remain sedentary and inactive.

Some forms of exercise, such as the Straighten Up program, focus specifically on improving spinal health and posture. Straighten Up is a simple, fun spinal health program, created because much of the technologically advanced world is literally in a slump, the poor posture slouch. Spearheaded by the chiropractic profession, Straighten Up is a multidisciplinary spinal health initiative designed to promote spinal health and excellent posture. Although Straighten Up is comprehensive in scope, with a platform of lifestyle enhancement recommendations, at its core it consists of a short set of active spinal exercises. Straighten Up is to the spine what brushing and flossing are to the teeth. The spinal exercises take only a minute or two to perform and are designed for daily use. They are exhilarating, fun, and easy to perform almost any time and anywhere.

Straighten Up's Posture Pod, exercises specifically designed for children, has been translated into 11 languages, with more translations in the works. It has been embraced by the multidisciplinary Bone and Joint Decade and several clusters of the World Health Organization, including the Occupational Health Cluster, the Health Promotion Cluster, and the Child and Adolescent Health Cluster.

Provided a person does not have spinal or shoulder disabilities that preclude exercise, he or she can begin Straighten Up immediately. A simple way to begin is by practicing the Posture Pod shown in **Figure 10-2** daily.

Tai Chi for Health

Tai chi is practiced by over 20% of the world's population and is fast becoming the most popular form of exercise in

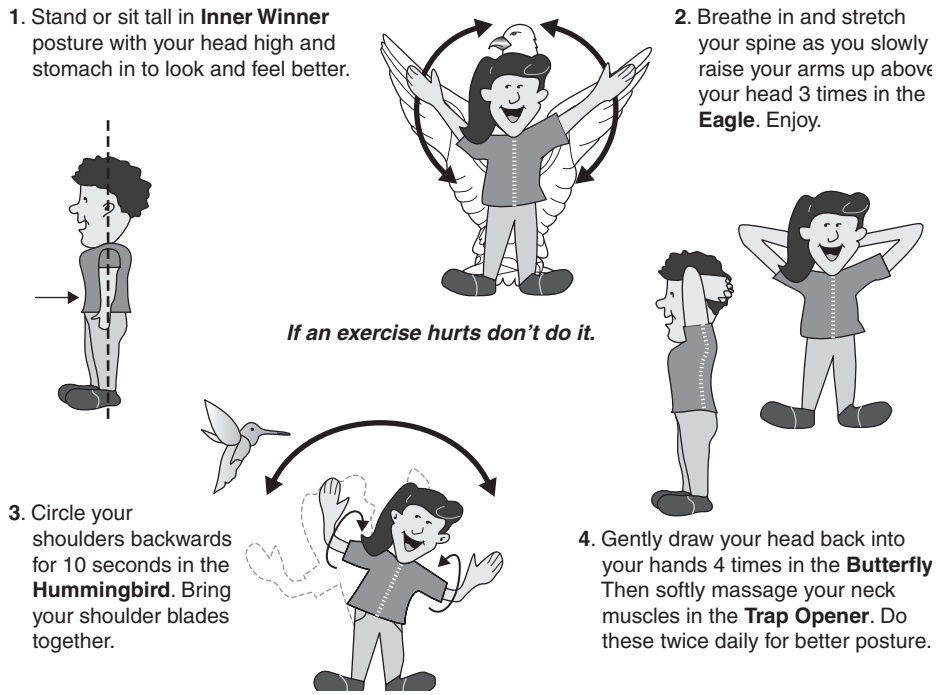

Figure 10-2 Posture Pod flying friends from Straighten Up.
Courtesy of Straighten Up America (www.straightenupamerica.org).

the world today. Tai chi is known as an internal martial art because its purpose is to develop and control internal energy. It is offered by many martial arts studios but is increasingly offered in a variety of venues including community programs, hospitals, and schools. Workplace tai chi programs help improve the health of workers and encourage creativity and relaxation. Programs in hospitals provide cost-effective therapy for many conditions. In addition to the standing forms, tai chi also can be practiced sitting down; individuals need not be physically fit to begin a program. The health benefits for older adults make it ideal for people with poor fitness levels to achieve significant health benefits including improved cardiorespiratory function, flexibility, and body composition.[37] Studies have also demonstrated a reduction in blood pressure[38] and an increase in bone mineral density.[39]

One of the most important benefits of regular tai chi practice for older people is improved balance that reduces the incidence of fall injuries.[40] Individuals who have less fear of falling in turn become more physically active.

A randomized controlled trial of tai chi published in 2007 reported augmentation of immune response to varicella zoster virus in older adults.[41] The tai chi group that received both the vaccine and tai chi produced substantially higher immune response values than the group that received the vaccine alone. In addition, the short-form 36-item health survey (SF36) scores showed significant improvements for physical functioning, vitality, and mental health along with a decrease in bodily pain.[41] A community-based tai chi program has also been found to produce beneficial effects and is recommended as a public health strategy to improve physical fitness.[42]

CONCLUSION

Physical activity is crucial because a sedentary lifestyle is a risk factor for many diseases and conditions. Making physical activity an integral part of daily life is important for everyone no matter their age. Physical activity need not be strenuous to be beneficial. People of all ages benefit from moderate physical activity, such as 30 minutes of walking five or more times a week. In addition, physical activity does not need to be sustained

for long periods of time in order to provide health benefits. Repeated shorter bursts of moderate-intensity activity, such as walking two 15-minute segments or three 10-minute segments regularly, also yield health benefits. Perhaps the most important factor in increasing physical activity is determining the right type of activity to suit each individual. The only good activity is one that is pursued regularly. Unless the activity is enjoyed for its intrinsic value it is difficult to sustain it for any length of time.

Clearly, the goal of a more active population will be a challenge, requiring a commitment to change on the part of individuals, families, workplaces, and communities. Physicians need more training in how to effectively counsel both children and adults in how to achieve healthier lifestyles. Both the public and private sectors need to band together to promote more healthy habits for those of all ages.[43] Encouraging more activity can be as simple as establishing walking programs at schools, worksites, and in the community. Some communities have an existing infrastructure that supports physical activity, such as sidewalks and bicycle trails, and work sites, schools, and shopping areas in close proximity to residential areas. In many other areas, such community amenities need to be developed to foster walking, cycling, and other types of exercise as a regular part of daily activity. Schools provide many opportunities to engage children in physical activity as well as healthy eating. For adults, worksites provide opportunities to reinforce the adoption and maintenance of healthy lifestyle behaviors. Perhaps the most important change, however, is at the individual and family level. Each person must understand the value of physical activity for his or her health and well-being and commit to a lifestyle that is truly active.

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CHAPTER
11

CHAPTER OUTLINE

The Public Health Impact of Musculoskeletal Conditions

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EPIDEMIOLOGY OF MUSCULOSKELETAL CONDITIONS

Back pain, including neck pain, is among the most common health problems encountered by adults in the United States, with just over 31% of Americans reporting these conditions in the past 3 months.[1] This was estimated by a look at the National Health Interview Survey (NHIS), and was among the first attempts to investigate the prevalence of lower back and neck pain and to examine the comorbid conditions associated with both of these in the United States. The NHIS is a face-to-face survey performed by the U.S. Department of Health and Human Services.[2] In this study, the percentage translated into approximately 34 million people with lower back pain and 9 million with neck pain. In addition, 19 million had both. Other assessments have suggested upwards of 70% of adults had back or neck pain in the previous 3 months, with a *lifetime prevalence* of more than 85%.[3]

The most frequent site reported for joint pain is the lower back, but approximately half of all joint pain sufferers report more than one site.[4] Lumbar spine conditions accounted for 1 in 25 health care resource visits at

the time of this writing. Back pain is among the most common ailments treated by doctors of chiropractic (DCs).[5] From a public health perspective, prevention of back pain is a Healthy People 2010 priority area. Section 2-11 of the document is "Reduce activity limitation due to chronic back conditions."[6] In addition, many other target areas such as dietary and physical activity recommendations are topics easily discussed by DCs in the practice environment. In 2000, age-adjusted baseline assessments indicated 32 people per 1000 age 18 or older experienced limitations due to chronic back conditions.[7] This number was even higher for lower socioeconomic groups and those with low income and education levels. **Table 11-1** shows limitations due to chronic back pain according to data derived from the NHIS.

Back pain is the most common physical ailment seen by medical physicians and represents about 5% of all annual health care visits to doctors, hospital emergency departments (EDs), outpatient clinics, and general hospitalizations.[4] Each year around 15% of Americans will see their doctor for back pain, and this percentage has been slowly increasing over the past decade. Undefined "joint pain" is also a very common complaint in the doctor's office, and according to the NHIS is frequently reported by survey participants. Although lower back pain prevalence increases with age, neck pain tends to stabilize in an age range of 45–64.[4] The most frequent diagnosis for lower back pain is *disc degeneration*, which is indicative of a chronic spinal condition. This is characterized by wear at the spinal disc level related to age, trauma, and other lifestyle factors such as tobacco use or obesity.[7–9]

Chronic spinal pain (CSP) adds to the overall picture of the impact for back and neck conditions on U.S. society. Von Korff and others investigated the prevalence of chronic spinal pain and associated comorbidities and estimated that almost one fifth of the U.S. adult population (19%) had CSP within the past 12 months.[8] In addition, almost 30% reported a lifetime prevalence of CSP. These patients were much more likely to suffer from other chronic pain conditions, including other

Table 11-1 Limitations in Activity Due to Chronic Back Conditions

Adults Age 18 Years or Older, 1997	Activity Limitations Due to Chronic Back Conditions (rates per 1000)
TOTAL	32
RACE AND ETHNICITY	
American Indian or Alaska Native	68
Asian or Pacific Islander	18
Asian	15
Native Hawaiian and other Pacific Islander	Data are statistically unreliable
Black or African American	36
White	31
Hispanic or Latino	28
Not Hispanic or Latino	32
Black or African American	36
White	32
GENDER	
Female	32
Male	31
FAMILY INCOME LEVEL	
Poor	77
Near poor	53
Middle/high income	24
EDUCATION LEVEL (age 25 years or older)	
Less than high school	54
High school graduate	35
Some college	28

Source: From http://www.healthypeople.gov.[6]

musculoskeletal disorders (MSDs). Chronic spinal problems come with a high price tag in areas such as health care expenditures, costs to society, and added physical limitations for those who suffer from these disorders when they lead to disability.[8–10]

RISK FACTORS FOR CHRONIC SPINE CONDITIONS

Although it is important to note the *prevalence* of acute lower back and neck pain, the public health focus for clinicians should be to prevent these conditions from becoming chronic. Reported risk factors for chronic conditions of the lower back often include obesity,[10] smoking,[11] lack of regular exercise, overexertion or heavy work, self-reported poor health status, dissatisfaction with employment, other types of chronic pain, restricted spinal mobility, and antecedents of psychosocial disorders.[12] Generally, back pain is more prevalent in women, with lower back pain occurring 56% of the time in females;[4,13] however, low back injury is more prevalent in males. Risk reduction efforts need to focus not only on specific spinal rehabilitation, but also on overall issues related to general health risks, because the same risk factors may predispose one to chronic spine problems and subsequent declines in overall health status over time.[9]

Rechtine and colleagues at an orthopedic spine clinic in Florida found the majority of their surgical fusion failures and postsurgical infection issues were in smoking patients.[11] They also cited studies that indicated degenerative changes in the neck and back were more frequent in smokers. Based on these observations, they developed a protocol that was successful in increasing the tobacco cessation rates in their clinic. Smoking may also make existing conditions in the spine worse. When patients with spine pain, including men and women with scoliosis, were studied, those with scoliosis had even stronger associations with back pain and smoking compared to those without scoliosis.[14] Another study found attempts at rehabilitation for smoking patients with chronic spinal disability were less successful, with smokers being more likely to quit rehabilitation programs prior to completion than nonsmokers.[15] This could be due to limited physical fitness, but either way reduces the chance for limiting or reversing morbidity.

Neck pain is also very common, with 1.5% of hospital visits due to the condition.[4] Furthermore, cervical pain may represent almost 60% of health care visits for upper back pain. Neck injury may include strains, sprains, fractures, or disc injury, and these account for approximately 30% of all neck pain. Cervical spine injury is therefore more of a burden than injury-specific conditions to the lower back, based on proportion. Although a majority of neck injury patients don't need hospital care, they do represent 69% of all ED visits for neck-related pain, according to the 2008 report, *The Burden of Musculoskeletal Diseases in the United States*.[4] According to this report, a majority (81%) of neck pain conditions can be attributed to those in the age range of 18–64. Females accounted for a higher percentage of neck pain visits to health care providers as well. Chronic neck pain and disability are thought to be common, with as many as 5% of North Americans being disabled due to the condition.[16] The 6-month prevalence for chronic neck pain may represent an additional 10%. Estimates in Europe have suggested the prevalence of neck pain ranges from 10–20%.[16]

Nonmodifiable *risk factors* for chronic neck pain are said to be age, gender, and genetics. Modifiable risk factors include smoking, environmental tobacco exposure, physical inactivity, low social support, high qualitative job demands, and sedentary or repetitive work routines.[9,10,12–14] The overall tendency is to suggest a *web of causation* for both chronic neck and back conditions, with the long-term prognosis being determined by multiple causations. That being said, addressing the modifiable issues with patients is clearly the place to start in the clinician's office. **Table 11-2** lists commonly cited risk factors for the development of chronic neck and back pain.

ARTHRITIS

According to the U.S. Centers for Disease Control and Prevention (CDC), around 16% of the U.S. population had some form of arthritis in 1997, translating into about 43 million people.[17] Estimates from the NHIS indicate that this could now extend higher, to upwards of 46.6% of U.S. adults with physician-diagnosed arthritis.[18] Arthritis, particularly *osteoarthritis (OA)*, is among the most common disorders in the world. It carries with it a high cost in terms of pain and disability, as well as high monetary expenditures for health care. Unfortunately, as the population ages, these numbers will continue to increase the burden of arthritis on society in the United States and the world. Estimates are that by 2030 over 25% of U.S. citizens (approximately 67 million people) will have arthritis and related disorders.[18] OA is the most frequent joint disorder in the world and occurs in about 80% of those age 75 or older.[19] This ranks it second only to heart disease as a

Table 11-2 Risk Factors for Chronic Back and Neck Pain[9–14]

Risk Factor	Neck Pain	Back Pain	Modifiable
Age	√	√	No
Dissatisfaction with job	Possibly	√	Yes
Gender	√	√	No
Genetics	Probably	Probably	No
High job demands	√		Yes
Low social support	√	Possibly	Yes
Mental comorbidity	√	√	Yes
Obesity	Probably	√	Yes
Other chronic pain	√	√	Possibly
Physical inactivity	√	√	Yes
Repetitive or heavy work	Possibly	√	Yes
Restricted spine mobility	Probably	√	Possibly
Sedentary work	√	√	Yes
Self-reported poor health status	Probably	√	Possibly
Tobacco smoke	√	√	Yes
Environmental tobacco smoke	√	√	Yes

cause of work-related disability in men over 50 and causes more hospitalizations than other forms of arthritis, including *rheumatoid arthritis (RA)*.[20]

Osteoarthritis is associated mostly with joint pain, and its prevalence increases with age. OA most commonly affects the joints of the hand, knee, hip, and intervertebral facet joints, with women being slightly more likely to experience OA than men and whites more so than other racial categories.[20] Other risk factors that have been considered are increased body weight, having a joint injury, joint deformity, weakness of correlating muscle groups, and to a lesser degree, diet and genetics.[20]

Helmick and associates reported that rheumatoid arthritis affects 1.3 million U.S. adults and almost 300,000 children in its juvenile form.[21] Rheumatoid variations such as psoriatic arthritis, systemic lupus erythematosus (SLE), ankylosing spondylitis (AS), and Sjögren's syndrome increase these numbers significantly. Currently, RA and its variations are not well understood and tend to be associated with joint destruction unrelated to the risk factors mentioned for OA. However, RA decreased in prevalence from 1955–1995, causing some to suggest a cyclic variation in the disease or possibly an environmental cause.[22] Risk factors vary for the individual rheumatic variations. For example, SLE affects women more frequently than men, whereas AS affects men more often. Regardless of the variety, arthritis causes significant morbidity and disability and can increase risk of premature mortality, particularly in the rheumatoid variants.[21]

OCCUPATIONAL MUSCULOSKELETAL INJURIES

According to the National Institute for Occupational Safety and Health's (NIOSH's) *Worker Health Chartbook* in 2000, approximately 5.7 million work-related injuries were reported in 1997.[23] Agriculture, construction, manufacturing, and transportation industries reported higher than average injury rates. Sprains, strains, and tears accounted for more days off work than any other injuries, with nearly half of the injuries occurring to the back. According to NIOSH, over 60% of back injuries were due to "overexertion." Rates of general injury were highest among men and workers under the age of 25. Seventy percent of all injuries in U.S. emergency departments are from lacerations, punctures, sprains, strains, contusions, abrasions, and hematomas.

According to NIOSH data released in 2000, for the year 1997 sprains, strains, and tears represented the largest number of joint injury events with approximately 799,000 cases.[23] Moreover, nearly half of those types of injuries involved the back, accounting for some 80% of all of the traumatic injuries to the back. Males suffered two thirds of those injuries, and half of the cases required 6 days or more off work. There were also 119,000 bone fractures in 1997 that resulted in days off work, with half of them requiring at least 21 days off work.

Fransen and others assessed workers suffering from occupational-related low back pain and found the

following predictors of chronic problems following injury: severe leg pain, obesity, Oswestry Disability Index scores indicating greater than minimal disability, lower than average general health scores on general health assessments, unavailability of light duty upon return to work postinjury, and jobs requiring lifting for the majority of a day.[24]

BACK AND NECK INJURIES

Similar to general joint-related injury, back injury may include fractures, sprains, strains, or disc injury, and often is reported to be caused by overexertion. According to the report, *The Burden of Musculoskeletal Diseases in the United States*,[4] back injuries currently account for 27% of ED visits and 11% of hospital visits.

Lumbar spine injuries currently represent about 30% of health care visits among those 18–44 years of age, and this was the highest proportion based on age groupings. Disc disorders were most common among people 45–74 years of age, representing 20% of health care visits for lower back pain in that age range.[4]

Neck injuries, including those sustained in motor vehicle collisions (e.g., whiplash), are a major source of musculoskeletal pain. In fact, about 11% of visits to hospital EDs for treatment of nonfatal unintentional injuries are attributable to motor vehicle collisions, with about half of those patients reporting a musculoskeletal sprain/strain.

COSTS ASSOCIATED WITH MUSCULOSKELETAL DISORDERS

There is a high societal and public health burden from musculoskeletal disease (MSD) and injury. MSDs have been reported to be the leading cause of disability in the United States and are responsible for more that half of all chronic disorders in people older than 50 years of age in developed countries. Disorders of the back and neck, arthritis, and musculoskeletal injuries alone constitute an expensive set of conditions for Americans. Unfortunately, they are among the most common of disorders and are associated in many cases with increasing age. The median age of Americans is increasing with the aging of the Baby Boomers, which will result in increased MSD-related costs to our public health system and our society in the years to come.[25]

Back and Neck Pain

Martin and colleagues analyzed a sample from the Medical Expenditure Panel Survey (MEPS) from 1997 to 2005.[26] This is a subset of the previous year's NHIS. In 2005, the mean age and gender-adjusted medical costs among persons with spine disorders was $6096, compared with $3516 for those without spine problems.[26] By the time of this writing, the estimated annual direct medical costs for all spine-related conditions exceeded $190 billion. Annual indirect costs added at least $14 billion due to lost wages from spine problems. To put this in perspective, the direct and indirect costs associated with all bone and joint health in the United States were estimated to be a staggering $849 billion in 2004, representing about 7.7% of the gross domestic product for that year.[4(p ix)]

Scientists investigating the prevalence and costs associated with spinal conditions also acknowledge the cost of the physical limitations associated with this type of pain. In addition, specific increases in the presence of comorbid conditions that are greater in chronic spine pain patients than in the general population without spine problems has been documented. The economic costs alone are high; however, with some 47% of those patients having at least one comorbid, nonspinal illness as well, the costs go even higher.[9] In this assessment, investigators stated that physicians and the health care system should realize the patient with spine pain endures a physical burden equal to or greater than those patients with chronic heart conditions, chronic obstructive pulmonary disease, cancer, and other serious orthopedic disorders. The economic burden is heavy as well.

The average whiplash injury caused by a rear impact collision in the United States costs approximately $9994 in 2002 dollars, which breaks down to $6843 in economic costs and $3151 in costs related to quality of life impacts. The total annual cost of rear impact whiplash injuries in the United States has been estimated from these data to be approximately $2.7 billion.

Arthritis

The CDC's *Morbidity and Mortality Weekly Report* profiled medical costs and indirect costs associated with arthritis and other rheumatic conditions in the United States from 2003 using the available MEPS data.[27] Estimates gathered in this report through 2003 suggested the total costs of arthritis and other rheumatic conditions was approximately $128 billion. Of that, $80.8 billion was due to direct costs and another $47 billion due to indirect costs such as lost time from work and disability. This was equal to 1.2% of the U.S. gross

domestic product and ranged from $225.5 million in the District of Columbia to $12.1 billion in California. The average per-person costs for the year were $1752, and the average lost earnings associated with arthritis were $1590.

Occupational Musculoskeletal Injuries

The 2000 NIOSH report suggested occupational MSDs cost the United States $13 billion annually; estimates from labor unions suggest these costs were $20 billion or more during that same time period.[23] According to NIOSH, work-related MSDs represent a major portion of the costs associated with work-related illnesses in the United States, and the mean costs associated with a lower back injury when compensated by the workers' compensation system were as high as $8321 in 1989. These costs are much higher today as the overall costs associated with health care have sky-rocketed.

Indirect costs associated with occupational MSDs increase the costs substantially. Lost wages, loss of productivity, retraining of employees who could not return to previous jobs, and overall costs to the country reflect a major burden on those with MSDs as well as the public health of the nation.

Every effort should be made by practitioners treating MSDs to attempt risk reduction education and health promotion with patients in an effort to reduce morbidity and disability associated with musculoskeletal disease. Although discussion of every MSD is beyond the scope of this chapter, problems with the knees, wrists, shoulders, and other joints are also quite common. For example, shoulder pain may represent 16% of all MSDs seen in a physician's office.[28] The prevalence of MSDs makes them a significant public health problem with a high price tag to the society in which they occur.

COMORBIDITIES OF CHRONIC SPINE DISEASE AND ITS PUBLIC HEALTH IMPLICATIONS

Obesity

At the time of this writing, the United States and many other nations are suffering from what some have called a pandemic of sedentary lifestyle and poor diet choices.[29] This is important to the topic of chronic spine disease (CSD) and public health because obesity is correlated with CSD and is considered a risk factor for it.[10] According to researchers at Dartmouth Medical School, obese patients with lower back pain are more likely to have neurological signs and other health issues, and to be at greater risk of receiving workers' compensation benefits for injuries. These researchers also found significantly higher pain and disability index scores in back pain patients who were obese. The findings trended across body mass index (BMI) categories for increased neurological signs and symptoms and radicular pain. Not only were higher BMI categories associated with more severe back problems, but *morbidly obese* patients—those with the highest BMIs—had almost twice the comorbidities as nonobese spine patients. Statistically significant increases in risks for cardiac disease, hypertension, lung disease, diabetes, gastrointestinal problems, depression, headaches, and arthritis were noted among the obese when compared to the nonobese spine patient. Researchers stated that obese spine patients were among the most functionally impaired patient groups—significantly more so than those who are not obese.

Other Comorbidity Issues

In addition to obesity, those who suffer from CSD are significantly more likely to have risk factors for other illnesses as well. In an assessment of over 17,000 patients with CSD, investigators found they were more likely female (54.7%), they had a mean age of 47.5 years, 84.2% were white, and they were significantly more likely to be obese, to smoke, or to have hypertension, diabetes, arthritis, peptic ulcer, asthma, and other comorbid conditions compared to those who do not suffer from CSD.[9] Almost 50% of them had at least one other nonspinal illness, and investigators stated that these patients had significantly more physical morbidity than the U.S. population in aggregate. They concluded that those with CSD have a similar disease burden to those with congestive heart failure, chronic obstructive pulmonary disease (COPD), cancer, and orthopedic disorders.

Von Korff and colleagues examined the physical and mental comorbidities associated with CSD and found it highly comorbid with other pain conditions and chronic diseases, including mental disorders.[8] Those researchers found about 19% of the U.S. population to be suffering from CSD within the prior 12 months, and 29.3% reported a lifetime prevalence of chronic spinal pain. Prevalence of CSD was three times as high in those with other chronic pain and two times as high

in those with a mental disorder. Among the conditions associated with CSD were stroke, hypertension, asthma, COPD, irritable bowel syndrome (IBS), ulcers, HIV/AIDS, epilepsy, and vision problems. They were also more likely to have neck pain and headaches, and be at greater risk of alcohol abuse and dependence. The researchers estimated that among the 40 million U.S. adults with CSD, 22 million had a chronic, comorbid physical disease. In addition, more than 68% of those with CSD had another chronic pain condition, more than 55% had at least one comorbid physical disorder, and 35% had a comorbid mental disorder. A full 87% had at least one of these three forms of comorbidity. These data should begin to paint the true public health picture for those with CSD and should be of interest to every clinician treating spinal conditions or MSDs.

Cardiovascular risk factors increased with symptomatic lumbar disc herniation, and scientists suggested a common link in the vascular risk factors for disc disease and atherosclerosis.[30] In this assessment of participants in the Nurses Health Study, smokers had higher rates of spine disease and there was a greater risk of physician-diagnosed disc disease in those with high cholesterol than those with normal cholesterol. However, this was attenuated in those who were nonsmokers or who smoked less than 15 cigarettes per day. The investigators suggested that smoking cessation and modification of other risk factors associated with atherosclerosis might reduce this association with disc disease. They further observed some increases in risks for former smokers but reductions in risks for those having quit 2 years prior, suggesting a dose–response relationship that could be reduced with tobacco cessation.

Zhu and others examined observational data of a cohort study originally designed to assess bone density, osteopenia, and calcium intake in Australian women 70–85 years of age.[31] They examined death certificates over 5 years and found greater risk of death from heart disease in those with a history of back pain. Increased back pain frequency was associated with reduced mobility at baseline and 5 years later, and quality of life scores decreased with increased back pain frequency. Back pain was also associated with lower physical and mental component scores on health questionnaires at baseline and at 5 years. Most surprisingly, the crude mortality rate was twice as high for those with baseline back pain as for those without back pain, after adjusting for age and physical activity levels (6.5% vs. 3.5%; hazard ratio = 2.03; 95% confidence interval, 1.14–3.60). Frequent back pain was related to a 78% higher risk of coronary event and daily back pain was related to a 113% increased risk of coronary heart disease, even after adjusting for age, physical activity levels, and other cardiovascular risks. The investigators speculated on causation but concluded that frequent back pain is a serious health problem in elderly women and may increase risks of mortality and coronary heart events in this population. Its management, therefore, should be considered for the well-being and functional independence of these patients.

ACTION NEEDED FROM SPINE PRACTITIONERS

Population studies on CSD cannot necessarily assign specific channels of causation. However, from just the few examples mentioned in this chapter, one should understand that CSD is a serious public health issue within the broader context of MSD. DCs are uniquely qualified and positioned to help those with CSD and to focus them on preventive efforts that may not only reduce their risks of becoming a chronic spine pain sufferer, but also reduce the risks of those diseases found to be comorbid with CSD. This will take a concentrated effort by the practitioner to assess patients' risks, have resources in place to help reduce them, and allocate proper time for delivery of cues to action that focus on preventive efforts. Multiple treatment visits logically increase the chances for delivery of health promoting messages in chiropractic offices when the doctor chooses to do so.

Current assessments of what DCs do in practice regarding health promotion tend to indicate that they are involved in prescribing therapeutic exercises, mostly specific to the joint-related conditions they are treating. According to the National Board of Chiropractic Examiners (NBCE) they may be including physical fitness or exercise promotion, nutritional and dietary recommendations, ergonomic or postural advice, advice on changing risky behaviors, self-care strategies, relaxation/stress reduction strategies, and to a lesser degree, disease prevention/early screening strategies.[5] DCs' self-reported utilization rates of each of these exceeded 90%, but self-reported estimates of the percentage of patients actually receiving the information or advice ranged from 64.9% receiving fitness and exercise recommendations "frequently" down to

39.7% "sometimes" receiving disease prevention and early screening advice. Jamison observed a similar trend among DCs in Australia and found 91% of chiropractors were prepared to provide information on exercise and 72% were prepared for diet advice, but only 35% said they were prepared to counsel on smoking.[32] Smoking cessation information was available in a minority of offices as was information related to the risks of cardiovascular disease, cancer, stroke, and osteoporosis. This was noted in spite of the fact that those risk factors have been highly correlated with chronic spine conditions in large epidemiologic studies and are considered top causes of early morbidity and mortality. This may reflect the false notion that some other practitioner, such as the family doctor, is more readily responsible for supplying that information to patients.

If clinicians want to call themselves spine specialists, it would seem important to want to prevent the patients they serve from becoming chronic—especially if this means they will likely suffer additional physical and mental conditions as a consequence. Efforts to assist patients in lifestyle changes needed to reduce these risks are essential if CSD and even chronic MSD is to be effectively countered. DCs have a unique opportunity to see their patients several times in treatment of acute conditions, and for those patients who choose to see the DC periodically, there is the potential for an increased dose-response if the patient is engaged on the subject of needed lifestyle modifications. The DC should address the subject of tobacco cessation with every user of tobacco products. They should address needed daily exercise with every patient, not just those who are visibly overweight. Exercise should be stressed as safe for those with even chronic back pain and arthritis.[18,33] Proper diet, including increasing the numbers of fruits and vegetables eaten per day, is essential to helping most patients reach a healthy weight and health-related nutritional goals. This should be part of any practice where better spinal health and increased physical function is the desired outcome.

The average family practice doctor has a few visits a year for engaging a typical patient on these needed changes, whereas DCs have multiple opportunities for that teachable moment. Clinics where spinal conditions are treated need to become more proactive in addressing the preventable causes of premature morbidity from CSD and the potential for premature mortality that may be associated with this condition. To do any less is inexcusable for those wanting to hold the status of spinal health specialist.

Clearly there is a need for DCs and other clinicians treating MSDs to engage their patients in the area of health promotion and prevention. This is especially true where CSD or chronic MSDs are setting the patient up for early morbidity or disability. Resources for the clinician wanting to emphasize more health promotion with their patients can be found in **Table 11-3**.

Table 11-3 Web Resources for Practitioners Who Want to Promote Health with Spine Patients

• American Heart Association (healthy living and risk reduction for overall health)	http://www.americanheart.org
• Centers for Disease Control and Prevention (advice on tobacco cessation for health care providers)	http://www.cdc.gov/tobacco/
• U.S. Surgeon General (tobacco, exercise, and other reports)	http://www.surgeongeneral.gov
• American Public Health Association	http://www.apha.org
• American Chiropractic Association	http://www.acatoday.org
• National Cancer Institute Fruit and Veggies More Matters (diet change and lifestyle)	http://www.fruitandveggiesmorematters.org
• Discovery Health	http://health.discovery.com
• Medscape	http://www.medscape.com/publichealth/
• American Diabetes Association	http://www.diabetes.org
• Overweight advising tips for clinicians	http://familydoctor.org

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CHAPTER
12

Tobacco, Alcohol, and Drug Abuse

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CHAPTER OUTLINE

INTRODUCTION

Often people who use tobacco, alcohol, or drugs will also use another of these substances. The existing data show strong correlations between the use of each of these substances with each other. For instance, among people 12 years or older, 20% of cigarette smokers over the past month reported current use of an illicit drug compared with 4% who did not currently smoke. Past month alcohol use by smokers was also higher by 50% compared to nonsmokers. Alcohol use, particularly heavy drinking, is strongly associated with illicit drug abuse—32% of heavy drinkers were current illicit drug abusers. Furthermore, alcohol consumption levels also were associated with tobacco use. Among heavy alcohol users age 12 or older, 61% smoked cigarettes in the past month, compared to 17% of nondrinkers. Heavy drinkers also used more smokeless tobacco (12% vs. 2%) and cigars (19% vs. 2%) than nonsmokers. Current illicit drug abuse was approximately eight times higher among adolescents who smoked cigarettes compared to nonsmokers. Strikingly, among youth ages 12 to 17 who were both smokers and heavy drinkers in 2005, 71% used illicit drugs, 20 times higher than the 3.5% of youth who did not drink or smoke.[1]

This chapter provides demographic statistics, identifies at-risk populations, lists many of the health effects, and discusses prevention approaches for tobacco, alcohol, and drug abuse. Understanding who is at risk, and for what conditions, is important for the alternative health care practitioner. Thus, at the end of this chapter, there is a discussion of the role of the chiropractor in treating patients with substance abuse and dependency issues.

TOBACCO

Statistics and Trends

In 2005, an estimated 71.5 million Americans age 12 or older were current (past month) users of any tobacco product, representing nearly 30% of the U.S. population in that age range. Most smoked cigarettes (24.9%), 5.6% smoked cigars, 3.2% used smokeless tobacco, and 0.9% smoked tobacco in pipes. Use of tobacco products between 2002 and 2005 slightly declined from 30.4% to 29.4%, and cigarette use decreased from 26.0% to 24.9%.[1]

Prevalence

The World Health Organization (WHO) estimates that approximately 650 million of the 1.3 billion people living in developing countries will eventually die of tobacco-related causes,[2] and that tobacco use represents a significant risk factor for six of the eight leading causes of death in the world.[3] Cigarette consumption, although decreasing in developed nations, has been found to be increasing at a rate of 3.4% per year in developing nations.[4] At the current rate, the estimated number of smokers will rise from 1.3 billion to 1.7 billion by 2025.[4]

Each year, cigarette smoking in the United States causes approximately 438,000 deaths and results in an estimated $167 billion in health care costs.[5] Although smoking rates are increasing worldwide, particularly in developing nations, rates in the United States are falling. In the United States, per capita consumption of cigarettes reached a peak in 1963, the year before the first Surgeon General's report on smoking was published. Consumption since that time has steadily declined. Since 1965, the prevalence of cigarette smoking among U.S. adults declined by almost half, with positive trends observed among people in almost all sociodemographic groups.

Over the past 40 years, not only have more people quit smoking, but fewer adults began smoking. The number of quitters increased from 24% in 1965 to 49% in 1994 and has since leveled off to 50.3% in 2003.[6,7] Forty-four percent of adults in 1965 never smoked, while 50% reported never smoking in 1991, jumping to 56.4% in 2003 and to 58.6% in 2006.[6–8] These declines are largely attributed to decreased smoking by men and most racial and ethnic minority groups. In the 1980s, smoking increased among adolescents, but then declined through most of the 1990s in all age groups, all race groups, and both sexes.[2,9]

Demographics

The Centers for Disease Control and Prevention (CDC) reports that 45.3 million Americans 18 years or older are daily smokers.[10] **Table 12-1** presents the most current available data (from 2006) for smoking status in the United States among persons 18 years of age or over by selected characteristics.

Age

There are some alarming statistics regarding tobacco consumption among America's youth. Three million U.S. adolescents currently smoke and an estimated 25% smoke at some time before high school graduation. This statistic represents a particular cause for concern

Table 12-1 Smoking Status Among Persons 18 Years of Age or Over, By Selected Characteristics: United States, 2006

Selected Characteristic	Current Smokers [Percent distribution (standard error)]	Former Smokers [Percent distribution (standard error)]	Nonsmokers [Percent distribution (standard error)]
Total	20.8 (0.34)	20.7 (0.33)	58.6 (0.43)
Male	23.5 (0.53)	24.8 (0.50)	51.6 (0.62)
Female	18.1 (0.41)	17.3 (0.42)	64.6 (0.55)
18–44 years	23.6 (0.52)	11.7 (0.37)	64.7 (0.59)
45–64 years	21.8 (0.59)	26.9 (0.61)	51.3 (0.72)
65–74 years	14.1 (0.83)	37.0 (1.21)	48.9 (1.23)
75 years or over	5.7 (0.58)	38.8 (1.33)	55.5 (1.31)
White	21.1 (0.40)	22.1 (0.38)	56.8 (0.49)
Black	21.8 (0.89)	13.7 (0.67)	64.5 (1.01)
Hispanic or Latino	14.5 (0.75)	15.0 (0.85)	70.5 (0.93)
American Indian or Alaska Native	26.9 (4.53)	23.0 (4.38)	50.2 (6.08)
Asian	10.7 (1.01)	11.6 (0.96)	77.7 (1.31)
Native Hawaiian or Other Pacific Islander	22.5 (5.41)	—	77.5 (5.41)
Less than high school diploma	28.9 (0.95)	19.9 (0.85)	51.2 (1.08)
High school diploma/GED	26.4 (0.76)	22.8 (0.69)	50.7 (0.84)
Some college	22.1 (0.64)	25.1 (0.69)	52.8 (0.79)
Bachelor's degree or higher	8.2 (0.42)	23.6 (0.69)	68.2 (0.75)
Less than $20,000	30.3 (0.88)	17.2 (0.64)	52.5 (0.98)
$20,000–$34,999	27.2 (0.90)	19.4 (0.72)	53.4 (1.00)
$35,000–$54,999	22.1 (0.88)	23.1 (0.86)	54.8 (1.05)
$55,000–$74,999	18.3 (0.95)	23.2 (1.08)	58.5 (1.27)
$75,000 or more	13.5 (0.67)	23.9 (0.85)	62.6 (0.96)

Source: Adapted from Pleis and Lethbridge-Çejku (2007).
Note: Relative standard error of greater than 30% and less than or equal to 50%.
—Quantity unknown

because it has been concurrently reported that 90% of Americans who smoke started before they turned 18, and every year 1.5 million begin smoking.[11] Cigarette use increases dramatically in the teen years and peaks at 41.2% among young adults ages 21 to 25 (**Figure 12-1**). Young adults have the highest rate of current use not only of any tobacco product (44.3%), but also of each individual tobacco product, including smokeless tobacco, cigars, and pipe tobacco.[12] As age increases past 25 years, the number of current smokers of that age decreases. Combining all data for people over 35 years old, less than a quarter (22.3%) are current smokers.[1] Interestingly, however, adults 18–44 years of age are more likely to have never smoked than adults 45 years of age or over.[10]

The rate of current cigarette use was lower among adolescents in 2005 than in 2002. Among adolescents ages 12 to 17 in 2005, an average of 10.8% smoked cigarettes, a decline from 13.0% in 2002. Following trends of all tobacco use in middle schools and high schools, the National Youth Tobacco Survey published results on tobacco use by year from 2000, showing a promising decline in tobacco use in youth (**Figure 12-2**).[13]

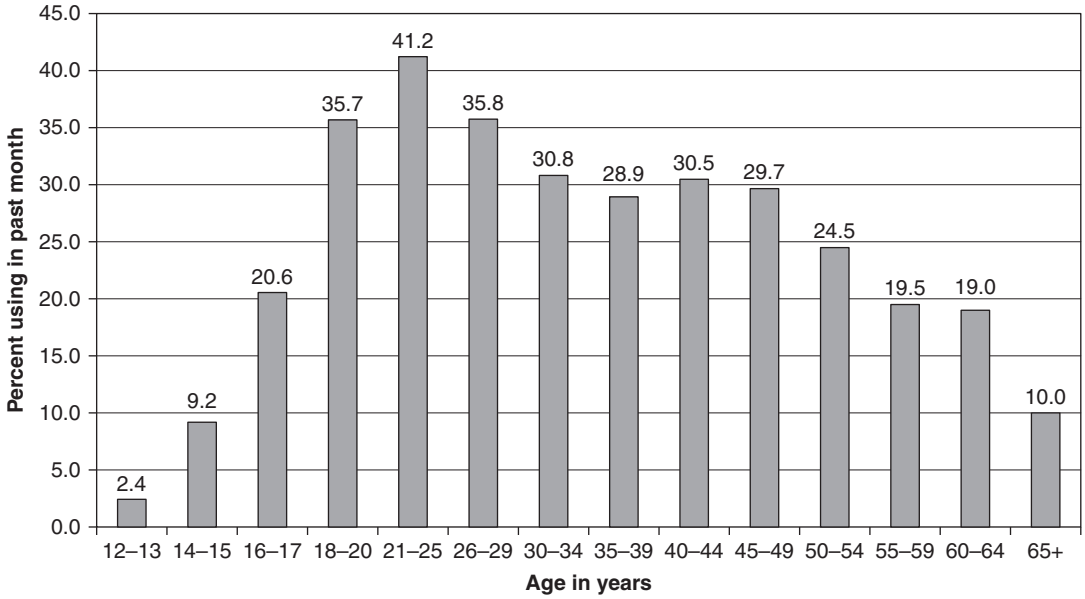

Figure 12-1 Percentage of U.S. population using cigarettes in the previous month by age group.
Source: Centers for Disease Control and Prevention. National Youth Tobacco Survey 2006.

Gender

Significantly more males than females age 12 or older currently use any tobacco product (35.8% vs. 23.4%) as well as specific forms, including cigarettes (27.4% vs. 22.5%), cigars (9.6% vs. 1.8%), and smokeless tobacco (6.1% vs. 0.4%). However, when analyzed by age, current cigarette smoking was equally prevalent between males and females ages 12 to 17 years (10.7% and 10.8%, respectively), but have seen significant declines since 2002.[1] White girls have the highest rate of smoking, followed by Hispanic girls; African American girls have the lowest rate.[14]

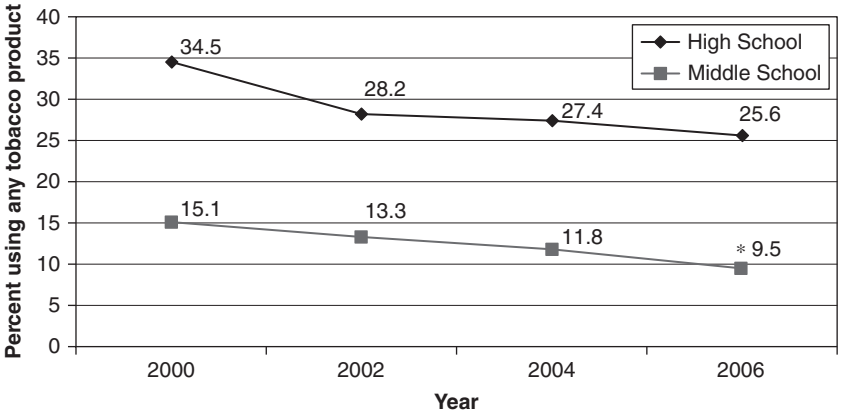

Figure 12-2 Decline in tobacco use in youth, 2000–2006, according to the National Youth Tobacco Survey.
Source: Centers for Disease Control and Prevention. National Youth Tobacco Survey 2006.

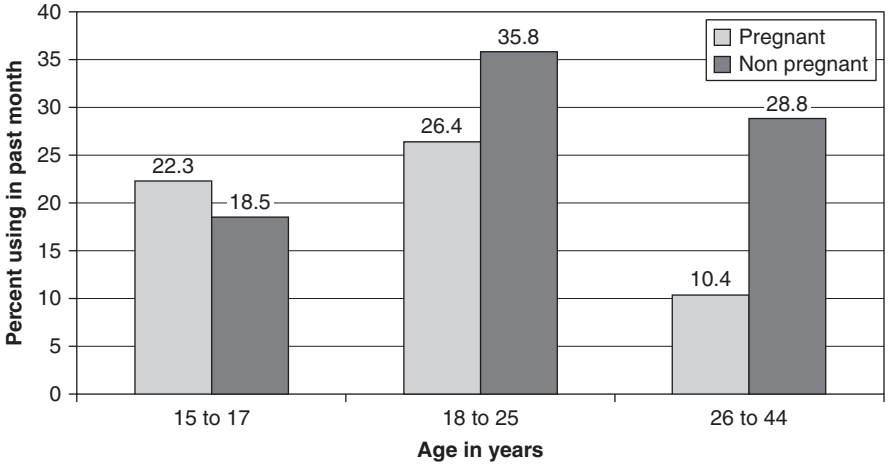

Figure 12-3 **Percentage of U.S. female population using cigarettes in the previous month, by age group and pregnancy status.**

Source: Centers for Disease Control and Prevention. National Youth Tobacco Survey 2006.

Pregnant Women

Pregnant women ages 15 to 44 are less likely to be smokers (16.6%) than those who are not pregnant (29.6%). Breaking this age group into smaller cohorts, the same trend holds true for women ages 26–44 (10.4% vs. 28.8%) and women ages 18–25 (26.4% vs. 35.8%) (**Figure 12-3**). However, among girls ages 15 to 17, the rate of cigarette smoking during pregnancy trended higher (22.3% vs. 18.5%), although not by a statistically significant margin. Similar data were observed in the combined 2002–2003 data.[1]

Race/Ethnicity

When analyzed by age, American Indians/Alaska Natives age 12 or older, as well as those age 18 or older, had the highest prevalence of tobacco use; the Asian American population had the lowest use (Table 12-1 and **Figure 12-4**). There were no statistically significant changes in past month tobacco use between 2004 and 2005 among any of these groups. Overall use of tobacco, and cigarette use in particular, is similar between black and white populations over 12 years of age. However, cigarette smoking is more prevalent in whites

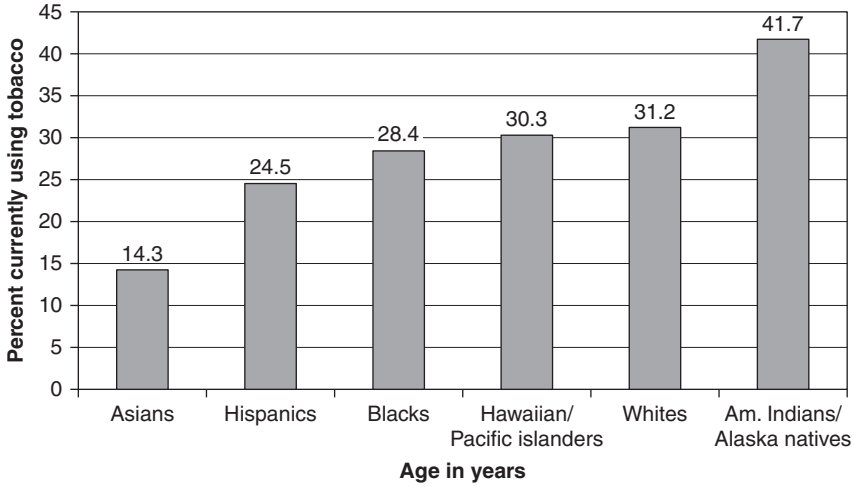

Figure 12-4 **Percentage of U.S. population using tobacco in the previous month, by ethnicity.**

Source: Centers for Disease Control and Prevention. National Youth Tobacco Survey 2006.

than blacks among both the 12–17 and 18–25 populations (12.8% vs. 6.5% and 44.2% vs. 28.7%, respectively). Among adults age 26 or older, however, whites and blacks used cigarettes at about the same rate (24.8% and 27.0%, respectively).[1,8]

Education

Formal education shows striking correlations with both smoking prevalence and smoking cessation rates. In order of prevalence, adult smoking was reported highest among those who had not completed high school, followed by high school graduates, people who had attended college, and college graduates (Table 12-1). Among young adults 18 to 22 years old, full-time college students were less likely to be current cigarette smokers than their peers who had not been enrolled full time in college (30.6% vs. 42.7%), despite the overall tendency toward smoking in this age group. Adults with at least a bachelor's degree were less likely than other adults to be current smokers and more likely to have never smoked.[1,8] Those with only 9–11 years of education have historically been shown to be current, ever, or heavy smokers, not to mention the least likely to have quit smoking. After 11 years of education, the likelihood of smoking decreases with each additional year of education. Even after being corrected for age, sex, poverty status, ethnicity, geographic location, marital status, employment status, and year of survey, the correlations held true.[6,15–17]

Employment, Income, and Health Insurance

Current cigarette smoking is more common among unemployed adults than among adults who are working either full time or part time (43.8% vs. 28.3% and 25.2%, respectively). Cigar smoking follows a similar trend. On a positive note, rates of current smokers age 18 or older decreased among unemployed people from 49.8% to 43.8% between 2002 and 2005.[1]

Adults in families that are poor are more likely to be current smokers and less likely to have quit smoking than adults in families that were near poor or not poor. Adults who are either uninsured or have Medicaid health care coverage are twice as likely to be smokers as those with private health insurance coverage. In addition, adults under 65 years of age who had private health insurance coverage were more likely to have never smoked than adults in this age group who were uninsured or who had Medicaid health care coverage.[1]

Geographic Area

Adults living in the West are less likely to be current or everyday smokers and more likely to have never smoked compared with adults living in other regions. Current smoking by people 12 or older was lowest in the West (21.0%) and highest in the Midwest (28.1%). Cigar smoking, like cigarette use, was highest in the Midwest (6.7%), and has increased from 5.6% in 2002. Among people age 12 or older, current cigarette use was associated with county type in 2005. The rates of cigarette smoking were approximately 29% in nonmetropolitan areas, 25.7% in small metropolitan areas, and 23.3% in large metropolitan areas. The rate for completely rural nonmetropolitan counties in 2005 was also 23.3%, declining from a peak of 31.8% in 2002.[1]

Environmental Tobacco Smoke (ETS)

Smoking affects the health not only of smokers, but also of nonsmokers. *Environmental tobacco smoke (ETS)* is of concern because it is the most important contaminant of indoor air. ETS is chemically similar to the smoke inhaled by smokers and contains a mixture of over 4000 chemicals. ETS is composed of both *sidestream smoke*, which is released directly from a smoldering cigarette, and exhaled mainstream smoke. Sidestream smoke has been found to contain much higher concentrations of tar, nicotine, and carbon monoxide than mainstream smoke because it has not been filtered by the smoker's lungs.[18] ETS mostly contains sidestream smoke; this is of concern as the almost all the vapor gas pollutants and more than half of the particulate matter are released from the burning cigarette. Five known human carcinogens, nine probable human carcinogens, and three animal carcinogens, as well as toxic compounds such as ammonia and carbon monoxide, are all higher in sidestream smoke than in mainstream smoke.[19] The Environmental Protection Agency declared ETS a group A carcinogen, placing it with other known carcinogens such as asbestos, benzene, vinyl chloride, and radon.[19]

Each year an estimated 3000 lung cancer deaths and 35,000 heart disease deaths among adults are caused by secondhand smoke exposure.[5,20,21] Secondhand smoke is also associated with health problems in young children. It is estimated that ETS contributes to increased symptoms of asthma for between 200,000 and 1 million children a year, and elevates the risk for chronic middle ear infections, asthma, bronchitis, pneumonia, and sudden infant death syndrome (SIDS).[18–20,22,23] In addition, children may be at a heightened risk of cancer later in life as

a result of exposure to ETS.[24] Compared to children who come from nonsmoking homes, children exposed to ETS have an average of 1.06 more days in bed, 1.45 more days absent from school, and 1.87 more days of restricted activity.[25]

At-Risk Populations

Individual sectors of the population are at greater risk for developing adverse health effects from direct smoke or ETS, including children, adolescents and the unborn child. Others groups are at greater risk than the general population to initiate smoking, continue smoking or not quit. Some of these groups and their associated risk factors are discussed below.

Women

Beginning in the 1920s, and especially since the late 1950s, tobacco companies have directed their marketing strategies toward women.[26,27] The CDC has claimed that the percentage of women who smoke approximates the percentage of men who smoke, and since 1985 have been abandoning the habit at approximately the same rate.[28] As with men, employed, blue-collar women are more likely to smoke than those in other occupations.[29] In addition, those with less education are more likely to smoke than those with a higher level of education. Particular to women, a number of studies suggest that fear of weight gain and "dual-role" stress make it more difficult for women to quit smoking, which may contribute to higher relapse rates.[14,30]

Although provisions have been made available by the U.S. government since 1993 to incentivize gender-based research, a review of the literature revealed that a void exists in outcome measures used to evaluate the effectiveness of control policies, particularly with respect to girls and women of low socioeconomic status.[31]

Smoking increases the probability of a woman getting lung cancer and is a critical risk factor in developing breast cancer.[32] In addition, research suggests that women who smoke have a greater difficulty getting pregnant, have fewer reproductive years,[30] and may experience early menopause.[33] Women who smoke also have higher incidences of vaginal bleeding, hysterectomies, and irregular menses.[34] Worse still, women who smoke and take birth control pills have a higher mortality rate compared to those who only take birth control pills.[35]

Relapse rates range from 70–85% among female smokers who quit some time during their pregnancy.[36–40] Although much information exists concerning rationale and strategies for smoking cessation among pregnant women, few studies address prevention of postpartum relapse. It has been argued that to maximize effectiveness, these programs should be part of routine health care, incorporate stresses particular to postpartum women, and involve each woman's support network.[41] Additionally, community-based educational interventions may help lower the prevalence of smoking and increase the number of quitters, as demonstrated by a women's-based program that was especially targeted at lower-income women of childbearing age.[42]

In Utero Infants

In utero infants are at greater risk for the harmful effects of smoking, as well as other environmental toxicants, possibly due to an immature immune system. The last 6 months of gestation are critical with regard to oxygen supply, and many have hypothesized about the mechanisms of maternal smoking on fetal oxygenation and fetal development.[43–45] It has been shown that women who quit smoking during the last 6 months of pregnancy improve their chances of having a normal-sized, healthy child and had comparable risk of stillbirth as nonsmokers.[46] However, women who continue to smoke double their chances of having a low birthweight infant and also increase their chances of premature delivery and stillbirth.[30,47] Minority low-income pregnant women should not smoke, because they are already at higher risk of poor birth outcomes.

Smoking during pregnancy is associated with alterations in the histology of the placenta[48] and an overall decrease in placental blood flow,[49] and can lead to abnormalities in the placenta associated with congenital malformations of the baby, such as anencephaly, spina bifida, congenital heart disease, cleft palate and lip, inguinal hernia, strabismus, urogenital anomalies, respiratory infection, decreased lung function, pulmonary hypertension, inner ear infection, and increased risk of childhood cancer and cancer later in life.[50,51] Additionally, the incidence of SIDS is higher in infants of mothers who smoked during pregnancy.[30] Furthermore, nicotine and its associated metabolic by-products can be transferred to the newborn through the breast milk.[52] In addition to the relationship between SIDS and maternal smoking during pregnancy, several studies have shown an independent association between ETS and SIDS. A dose-dependent relationship has been observed with the number of cigarettes, number of smokers in the household, and duration of exposure to ETS.[43–45,53] In 1997, the California Environmental Protection Agency

(EPA) deemed that the evidence was sufficient to conclude that there was a causal relationship between ETS and SIDS.[54]

Less serious, yet equally disturbing data demonstrate a relationship between maternal smoking and increased psychiatric symptoms in the child, particularly once the child is over the age of 14. Some of these symptoms include rule-breaking tendencies, aggressive behavior, symptoms of attention-deficit/hyperactivity disorder (ADHD), and social maladjustment.[55]

Children and Adolescents

Tobacco use among youth continues to be a problem in the United States.[56] In 2004, a total of 2.1 million people smoked cigarettes for the first time, most of whom were under the age of 18 years.[57] Approximately 91% of adult smokers start smoking before the age of 20, and 77% become daily smokers before the age of 20.[58] A large study in 1999 reported over 60% of high school students 16 years or older reported having smoked at least one cigarette, with more than 11% reporting that they started under the age of 10.[59] Although the prevalence of lifetime cigarette use remained stable during the 1990s, it declined significantly from 70.4% in 1999 to 58.4% in 2003,[60] mirroring similar trends observed in both middle school and high school over the same time period (Figure 12-2).

Adolescents are at increased risk for smoking, because the decision to smoke is influenced by several developmental characteristics including the process of separating from home, gaining independence, and acquiring adult skills. The influence of the peer group plays an important role in smoking initiation during adolescence. For example, teenagers grossly overestimate the percentage of peers who smoke,[61] and the estimate that 20% of all high school boys use smokeless tobacco[62] may be due to the view that it has a less serious health risk and is a more socially acceptable behavior than cigarette smoking.[63] Individual factors, such as peer group smoking,[64–70] parental smoking,[71] and low levels of parent–child closeness[69,72–76] are a greater predictor in youth smoking initiation and progression to a daily habit than race or ethnicity.[77]

Vulnerable Populations

People who experience difficulty in their lives have increased rates of smoking. Smoking is particularly common among divorced or separated men in the U.S. general population.[78] Also, as previously discussed, smoking is more common among blue-collar workers, the unemployed and less-educated,[6,15–17,78] and those with little wealth and material possessions.[79] A recent study in Helsinki reviewed six socioeconomic differences between smokers and nonsmokers and found that among both men and women, smoking is associated with material as well as perceived socioeconomic disadvantage.[80] Stress and psychiatric disorders, such as ADD/ADHD and depression, have been linked to elevated adolescent smoking rates.[81,82] People who become depressed are more likely to initiate smoking, continue smoking, and not quit.[83]

Minorities

The National Health Interview Survey (NHIS) made data available for smoking prevalence among whites, blacks, and Hispanics beginning in 1978. Although prevalence toward smoking between 1978 and 1995 dropped for all ethnic groups, cessation rates are a different story. The prevalence of quitting among smokers in 1995 was 50% for whites, 36% for blacks, and 47% for Hispanics. Studies at the time showed that although blacks were more likely than whites to try to quit smoking, they were less likely to succeed, even when the data were adjusted for demographic differences and adjustment for other tobacco use.[17,22,84] Although there has been shown to be disparity among blacks and whites in particular with initiation and cessation rates, there appears to be little or no correlation between smoking and ethnicity once socioeconomic factors are normalized.[85] Thus, environment, either perceived or real, plays a significant role in initiation, progression, and cessation of smoking. Interestingly, perceived racial harassment among black college students was correlated to a twofold increase of tobacco use.[86]

Health Effects of Smoking

Smoking is a major cause of cancer and cardiovascular and respiratory diseases.[87] Strong evidence exists for a link between smoking and both illness and death. Mortality rates for men who smoke are approximately twice that of nonsmoking men, as seen in two large cohort studies after a 5-year follow-up[88] and 40-year follow-up.[89] Male smokers had a 13-fold risk of developing chronic obstructive pulmonary disease (COPD), a 15-fold risk of developing lung cancer, and a 1.6-fold risk of developing ischemic heart disease compared to men who never smoked.[89] In a similar cohort study of 6194 women, with 22-year follow-up, significant associations

between cigarette smoking and lung cancer, ischemic heart disease, and COPD were all observed.[90]

Coronary Heart Disease

Coronary heart disease (CHD) is related to several risk factors, one of which is tobacco use. Of all diseases in which tobacco use is a risk factor, CHD is the leading cause of death and disability in the United States. In 1990, the Surgeon General's report estimated the risk of CHD from smoking and stated that "cigarette smoking is firmly established as an important cause of coronary heart disease, arteriosclerotic peripheral vascular disease and stroke."[84] Many effects of smoking cessation have been studied, with the Surgeon General's report concluding that cessation substantially reduces the risk of CHD among men and women of all ages, and after 15 years of abstinence, the risk of CHD becomes similar to the risk for those who have never smoked.

Smoking has also been well documented as a causal factor for stroke.[91,92] In adult men, the relative risk of stroke was 3.7-fold greater among smokers and 1.7-fold greater among past smokers, compared to men who never smoked.[93] Risk of cerebral infarction was found to be elevated to 1.9-fold and subarachnoid hemorrhage to 2.9-fold among active smokers.[94] Compared with continued smoking, cessation reduces the risk of both to levels of never smokers.[84]

In 1997, the California EPA reported that there was sufficient evidence to conclude that there is a causal relationship between ETS and cardiovascular disease.[54] Various clinical and experimental studies suggest that the mechanisms of ETS on cardiovascular disease include increased oxygen demand, platelet aggregation, and thrombosis, and decreased oxygen supply. As might be expected, these same physiologic effects are observed in the active smoker, and are commonly attributed to nicotine and carbon monoxide, but may well be due to other factors.[95] When healthy young nonsmokers were exposed to passive smoke, coronary flow velocity reserve dropped significantly to levels seen in smokers and appears to be a factor in ischemic heart disease; this should be considered as part of the etiology of endothelial pathology.[96]

Cancer

All cancers account for nearly a quarter of all deaths in the United States. Lung carcinoma is the leading cause of cancer death for both men and women, accounting for more than one quarter of all cancer deaths and nearly 7% of all deaths in the United States.[97] It has been estimated that 83% of lung cancer deaths were directly attributable to smoking.[22] Although the 1964 Surgeon General's report was the first official statement on the relationship between smoking and lung cancer,[98] the question was posed as far back as the late 1920s, and animal studies in the 1950s showed a clear association between smoking and lung cancer.[99,100] For people who stop smoking, the decrease in lung cancer mortality risk is gradual, and after about 10 years the risk is approximately 30–50% the risk of continuing smokers.[84]

Additionally, passive smoking has been judged to be causally associated with lung cancer. Each year, an estimated 3000 lung cancer deaths are attributed to secondhand smoke exposure.[5,20,21] In 1985, the U.S. Public Health Service, the National Research Council, and the Interagency Task Force on Environmental Cancer, Heart and Lung Disease independently convened and arrived at a consensus that a substantial number of nonsmoker lung cancer deaths were due to involuntary ETS.[18,23,101] Supporting these conclusions, the largest case-control study to date found a significant increase in lung cancer among women exposed to ETS in a dose-dependent relationship.[102]

Large numbers of cohort and case-control studies support the conclusion that smoking is causal for other cancers as well, including oral, laryngeal, and esophageal cancer, but there may be only a small increased risk of oral cancer with smokeless tobacco.[103] Interestingly, alcohol appears to play a synergistic role with smoking for oral, laryngeal, and esophageal cancer.[104–106] In general, smoking cessation reduces the risk of these cancers by approximately 50% within 5 years of quitting.[84] Other cancers also attributed to smoking include bladder and renal cancer,[84,107,108] pancreatic cancer,[91] stomach cancer,[91,109,110] and cervical cancer.[84,111–113]

Chronic Obstructive Pulmonary Disease (COPD)

In 2000, there were 119,000 deaths due to COPD[114]; approximately 80% of them were due to smoking.[22] Abnormal lung function occurs as early as 2 years after smoking initiation, beginning with inflammation of the small airways.[115–117] Smoking aggravates the principal chronic respiratory symptoms, including chronic cough, phlegm, wheezing, and dyspnea. Smokers who quit have better pulmonary function than continuing smokers and have a lower mortality rate, which can be determined by prior smoking patterns and number of years since quitting.[84,118]

Other Diseases and Conditions

Cigarette smoking has been linked to a number of other conditions including Graves' disease, autoimmune thyroiditis,[119] insulin resistance/glucose intolerance,[119–121] and increased risk of diabetes. One study followed more than 114,000 women who were free of diabetes over 12 years and found that smoking was associated with a 40% increased risk of diabetes for women smoking 25 or more cigarettes per day.[122] This may be due to the fact that smoking decreases fasting insulin levels and causes a transient increase in blood glucose levels.[120,123] Glucose intolerance is correlated to the level of smoke exposure, with smokers having the highest incidence, followed by nonsmokers exposed to ETS, previous smokers, and nonsmokers not exposed to ETS.[124] Complicating this, women with type II diabetes mellitus who smoke are 66% more likely to develop CHD.[125]

Other findings include that tobacco cessation leads to increased weight and blood pressure and may be responsible for the observation that new cases of hypertension are more common in women who quit smoking.[126] Also, an inverse relationship between the number of cigarettes smoked and visible mammographic density was observed among current female smokers,[127] illustrating the antiestrogenic effect of cigarette smoking on female breast tissue.[128,129] This antiestrogenic effect may also be responsible for the increased incidence of osteoporosis, fertility problems, and premature menopause seen in smokers.[119]

Among healthy adults, the most common complaints after exposure to ETS are irritation to the conjunctiva of the eye, mucous membranes of the nose, throat, and lower respiratory tract. In addition to reddening, itching, tearing, cough, and sore throat, symptoms associated with allergies may be exacerbated, including headaches, wheezing, and hoarseness.[19,130] In children, ETS exposures are important predictors of respiratory health outcomes in children 4 years or older.[131]

A number of studies have shown the association between passive smoking and dietary factors affecting wellness. Research has shown that lifestyle behaviors, including eating less healthful diets and drinking more alcohol,[132–134] differ between smokers and nonsmokers. Specific micronutrients associated with lower intake among smokers include beta-carotene or carotene,[135–138] retinol,[136,139] alpha-tocopherol,[139] and vitamin C.[136,139–141] Interestingly, however, a few studies have shown that exposure of nonsmokers to ETS may result in decreased circulating plasma concentrations of some micronutrients including carotenes and vitamin C.[141] It has been proposed that exposure to ETS, which is a source of oxidative stress,[142] may directly deplete antioxidant micronutrients.[143,144]

Intervention and Counseling

Quitting smoking has been found to extend life substantially, regardless of the age of cessation. Those individuals who stop smoking by age 35 years have an average increase of 8.5 years of life, and even those who quit at age 65 have an average expected increase of about 3 years of life.[145] Smoking cessation also decreases prevalence of major diseases. For example, the Lung Health Study showed that smoking cessation after 5 years results in a slower decline in forced expiratory volume in 1 second (FEV_1), reduces fatal and nonfatal cardiovascular disease, and reduces coronary heart disease.[146,147] As would be expected, the benefit was greatest for patients who quit smoking entirely.[148]

Primary Prevention

Primary prevention is defined as the prevention of disease onset or injury before the disease process begins by removing the causative agent. Primary prevention decreases incidence, or the number of new cases of a disease in a defined population during a specified time period. Although it remains difficult to remove legal substances such as alcohol or tobacco from the marketplace, most primary prevention strategies target illegal use or public policy.

State spending on tobacco control has dropped from a high of $749.7 million in 2002 to $551 million in 2006.[149] As of late 2005, only four states (Colorado, Delaware, Maine, and Mississippi) were spending the minimum per capita amount that the CDC recommends for tobacco control programs,[149] even though some research demonstrates that tobacco control programs are more effective with both increased state spending and increased length of commitment.[150] Achieving the goal of reducing the health and economic burdens of tobacco use requires commitment and collaboration among state decision makers, public health officials, business leaders, community members, and national partners.

Over the past two decades, new awareness of the harm of secondhand smoke has led to some effective actions against smoking. As studies reported that ETS exposure causes many of the same health problems seen in smokers (e.g., nonsmoking spouses and children have increased risks for heart and lung diseases), political pressure was placed on local and state governments.

In 1974, Connecticut became the first state to place bans on smoking in restaurants, with Minnesota following with a more comprehensive plan of a statewide clean indoor air law. In 1983, San Francisco passed a law prohibiting smoking in the workplace. Since then, many laws have been passed restricting smoking on public transit and elevators, schools, libraries, and recreational facilities. In 1989, Congress passed a ban on smoking on all domestic airline flights, despite the objection of the airline industry.

Approximately half of the U.S. population lives in states with a state-wide smoking ban (restaurants, bars, and workplaces). California has led the way in the most restrictive and prohibitive laws. For example, in 1990 San Luis Obispo became the first city in the world to ban smoking in all public buildings; in 2003 Solana Beach became the first California city to ban smoking on the beach; and in what is the strictest ban in the United States, Calabasas banned smoking in all indoor and outdoor public places in 2006, with only a few exempt designated outdoor smoking areas.

Smoking cessation politics are not black and white, however, and loopholes can be easily exploited. For instance, while under a smoking ban, researchers in England found that as many as 98% of pubs allowed some smoking on the premises, and 71% allowed smoking at the bar even though the government estimated that only between 10% and 30% met exemption criteria.[151] This is significant in that these findings illustrate that the smoking culture is difficult to control and that noncompliance could potentially damage the government's credibility when creating future successful smoking cessation campaigns.

This information is not included as an indication that smoke-free legislation does not work or has not proved successful. Reports from the U.S. Census Bureau state that smokers who lived or worked under a total smoking ban were more likely to report a quit attempt. Among those who made a quit attempt, those who lived or worked under smoking restrictions were more likely to be in cessation for at least 6 months. Additionally, smokers who were under the smoking ban were more likely to be light smokers than those who were not under the ban.[152] In another study, cotidine levels (a metabolite of nicotine) in nonsmokers were shown to significantly drop after implementation of a law prohibiting smoking in virtually all public enclosed places in Scotland.[153] In yet another study, New York hospital admission trends for acute myocardial infarction and stroke from 1995 to 2004 identified a striking 8% decrease in admission rates due to the implementation of a comprehensive smoking ban, resulting in an estimated health care cost savings of $56 million.[154]

Secondary Prevention

Secondary prevention is defined as the early diagnosis of disease or injury by screening followed by appropriate treatment to limit disability or prevent more severe manifestations. Secondary prevention decreases prevalence (the total number of persons living with a disease at any given time) and limits disability.

After a patient has been identified as a substance user, the physician should assess the level of dependence using either qualitative or quantitative methods, such as the Fagerstrom test,[155] which has been validated psychometrically and biochemically.[156–158] Automated systems incorporating guidelines such as the U.S. Department of Health and Human Services (DHHS) Tobacco Use Cessation (TUC) Automated Clinical Practice Guideline, which automatically prompts the clinician to counsel a patient during their visit, have been shown to be more effective than manual systems by improving documentation and appropriateness of testing and treatment decisions, while reducing the cost of health care.[159] These systems are widely advocated[160–163] and have been demonstrated to improve preventive practices[164,165] as well as improve physician comfort in counseling patients about smoking cessation.[166]

Tertiary Prevention

Tertiary prevention, applied to patients with disabilities, aims to reduce the impact of the disease and promote quality of life through both active rehabilitation and physical therapy. It should be noted that a referral is not required to initiate smoking cessation therapy, and it is important for all physicians to address issues of smoking cessation. Some evidence of the importance of physician involvement comes from a retrospective analysis of more than 1500 past-year smokers, which revealed that being asked about smoking by two or more types of professionals more than doubled the odds of recent quitting, and almost tripled the odds of making a quit attempt in the past year. Interestingly, this study did not find any significant increases in quitting, quit attempts, or readiness to quit among smokers who reported intervention by only one type of health professional.[167] Conversely, a brief intervention through counseling without follow-up is not sufficient to maintain abstinence at 12 months.[168]

Repetitive smoking cessation intervention programs with or without nicotine replacement or drugs are effective in reducing smoking-related mortality.[148] In contrast, a single brief intervention of female smokers emphasizing the health effects of ETS on their children, with subsequent postcard reminders at 2 and 16 weeks, was not a sufficient intervention to significantly increase cessation rates.[169]

The chiropractor is free to use a number of behavioral modalities for smoking cessation, including but not limited to physician advice, group behavior therapy, and self-help therapy. There is a direct relation between the duration and intensity of programs and cessation rates; therefore, a health care professional should not hesitate to refer to more intensive smoking cessation programs. A systematic review examining smoking cessation therapies with at least 6 months of follow-up showed that the absolute reduction in the smoking rate was 2%.[170] It is unclear if self-help materials increase cessation rates, but if so, the magnitude of benefit is small.[171,172] Moreover, the combination of self-help materials and nicotine replacement therapy did not show any increase in smoking cessation. Personalized materials and follow-up, however, did increase smoking cessation rates.[171]

Certain populations may be more susceptible to intensive smoking cessation messages. The results of a systematic review revealed that smoking cessation counseling was effective for pregnant women (8%, 10 trials), people who have suffered a myocardial infarction (36%, 1 trial), and men at risk of ischemic heart disease (21%, 4 trials).[170] Other studies have shown smoking cessation programs to be effective for patients with COPD[173] and those hospitalized with acute cardiovascular disease.[174] A recent systematic review of 34 trials of smoking cessation programs implemented during pregnancy found that women who had intervention were twice as likely to quit smoking, and were only 80% as likely to have both low birth-weight children and a preterm birth. In addition, an increase in mean birth weight was observed with women who participated in the program.[175]

Meta-analyses of the effects of smoking cessation after myocardial infarction revealed that patients who continued to smoke doubled mortality rates,[176] but the mortality of those who quit smoking postinfarct approached that of nonsmokers within 3 years.[177] Quitting also benefits smokers by lowering mortality rates after coronary artery bypass surgery, after coronary angioplasty, and in those with coronary stenosis.[178–181] An intensive smoking cessation intervention that targeted smokers hospitalized with acute cardiovascular disease not only increased abstinence rates (33% intervention vs. 9% usual care), but also reduced hospitalizations and all-cause mortality (2.8% intervention vs. 12.0% usual care) over a 2-year follow-up period.[174]

A variety of strategies have been implemented to prevent tobacco use and promote cessation for youth, including school-based interventions, increased tobacco excise taxes, and clinical smoking-cessation interventions.[182,183] Anti-smoking media campaigns also have been found to be effective in reducing adolescent cigarette consumption. For example, the American Legacy Foundation's national "Truth" campaign features youth attempting to positively change adolescent attitudes about tobacco use. Youth who were exposed to this campaign reported high rates of message recall and reduced rates of smoking behavior.[184,185] In addition, telephone "quitlines" marketed to teenagers may help adolescents quit successfully.[186] The Internet is also a powerful tool that is beginning to be used for smoking cessation programs. For example, http://www.gottaquit.com, sponsored by New York and national advocacy groups and introduced in 2001, was designed to help youth quit smoking. This campaign was found to be effective in that it reached almost all teens, and the Web format is likely to be used by adolescents seeking assistance with quitting.[187]

All currently evaluated forms of nicotine replacement therapy appear equally effective at increasing cessation rates by about 1.5- to 2-fold at 6 months among motivated persons, equivalent to a smoking cessation rate of 17%.[188] The evaluated forms of nicotine replacement therapy include nicotine patch, nasal spray, inhaler, gum, sublingual tablet, and lozenge. Combination therapy with nicotine products may increase cessation rates over mono-therapy, although insufficient evidence exists at this time to make a firm recommendation.

ALCOHOL

Alcohol is the most widely used psychoactive drug in the United States. Alcohol abuse is a common problem, yet it often goes untreated. There are efficient screening methods to identify abusers, and intervention with problem drinkers or those with severe alcohol dependence that can lead to better personal health and quality of life for their families. The most recent data show that alcohol contributes to 85,000 deaths annually, making it the third leading cause of preventable mortality in the United States, after tobacco and diet/activity patterns.[189]

Statistics and Trends

In 2005, slightly more than half of Americans 12 years or older reported being current drinkers (51.8% or 126 million people), and more than one fifth (22.7% or 55 million people) of the population age 12 or older participated in binge drinking in the past month. Heavy drinking was reported by 6.6% of the same population, or 16 million people, similar to the rates of heavy drinking in 2002 (6.7%), 2003 (6.8%), and 2004 (6.9%).[1] Some key definitions to understand include an *alcoholic drink*, which is 12 ounces of beer, 5 ounces of wine, or 1.5 ounces of distilled spirits (80 proof).[190] *Current (past month) use* is defined as having at least one drink in the past 30 days (includes binge and heavy use). *Binge drinking* is generally defined as consumption of five or more drinks for men (four or more drinks for women) on one occasion on at least 1 day in the past 2 weeks.[191–193] In 2004, the National Institute on Alcohol Abuse and Alcoholism (NIAAA) revised its definition of binge drinking to include "in about 2 hours" in an effort to incorporate the duration of the drinking episode. This addition to the definition, at least with respect to college students, may capture an element of risky alcohol use that could not be appreciated before.[194] *Heavy drinking* is having five or more drinks on the same occasion on each of 5 or more days in the past 30 days. *Moderate drinking* is defined as no more than one drink a day for women and no more than two drinks per day for men.

Prevalence

Alcohol represents a major contributor to morbidity and mortality in the United States.[195] Excessive alcohol consumption accounts for an annual toll of approximately 75,000 deaths and $184 billion in economic costs in the United States.[196–201] Binge drinking is serious because it often results in acute impairment and is associated with a variety of problems including motor vehicle crashes, other unintentional injuries, assaults, domestic violence, rape, unintended pregnancy, vandalism, alcohol poisoning, and alcohol dependence.[196,198,199,202,203] The reduction of binge drinking among adults is a leading health goal in Healthy People 2010.[56] Binge drinking rates vary considerably among adults by state,[203] as do alcohol control policies.[204] State-specific laws and policies are important predictors of alcohol consumption and alcohol-related problems among adults and underage youth.[197,205,206] A study about the density of liquor stores and bars in urban neighborhoods in the United States showed that blacks and nonwhites in lower-income areas face a higher density of liquor stores than do whites in lower- and higher-income areas and nonwhites in higher-income areas. This mismatch between the supply of liquor stores and the alcohol demand forms an environmental injustice for minorities and lower-income people that puts them at risk for adverse consequences for drinking behavior.[207]

Demographics

Age

In 2006, rates of current alcohol use peaked among people 21 to 25 years of age, although a significant number of youth consumed alcohol (**Figure 12-5**). Among older age groups, the prevalence of alcohol use decreased with increasing age, from 63.7% among 26- to 29-year-olds to 40.0% among people age 65 or older. In 2006, rates of binge alcohol use peaked at age 21 (49.9% at age 21, 46.6% at age 22, and 47.7% at age 23), then decreased beyond young adulthood (Figure 12-5). Grouping 18- to 25-year-olds, the rate of binge drinking was 41.9% and the rate of heavy alcohol use was 15.3%. These rates are similar to the rates in each year since 2002,[1] suggesting that they have stabilized following the slow increase seen between 1993 and 2001.[203] People age 65 or older had lower rates of binge drinking (8.3%) than adults in other age groups, and their rate of heavy drinking was 1.7%.[1] The rate of current alcohol use among youth ages 12 to 17 declined from 17.6% in 2004 to 16.5% in 2005. Youth binge drinking also declined during that period, from 11.1% to 9.9%, but heavy drinking did not change significantly (2.7% in 2004 and 2.4% in 2005).

Gender

In 2005, 58.1% of males age 12 or older were current drinkers, whereas the rate for females was 45.9%. However, among youth ages 12 to 17, the percentage of females who were current drinkers (17.2%) was higher than that for males (15.9%). Among adults ages 18 to 25, an estimated 55.4% of females and 66.3% of males reported current drinking in 2005. These percentages are similar to 2004.[1] Although males were slightly more likely to use alcohol than females, they were much more likely to engage in binge drinking and heavy drinking.[1]

Data collected between 1976 and 2000 showed that nationally, alcohol use by high school girls was unacceptable. Fifty-two percent of 8th-grade girls, 72% of 10th-grade girls, and 81% of 12th-grade girls had used alcohol at least

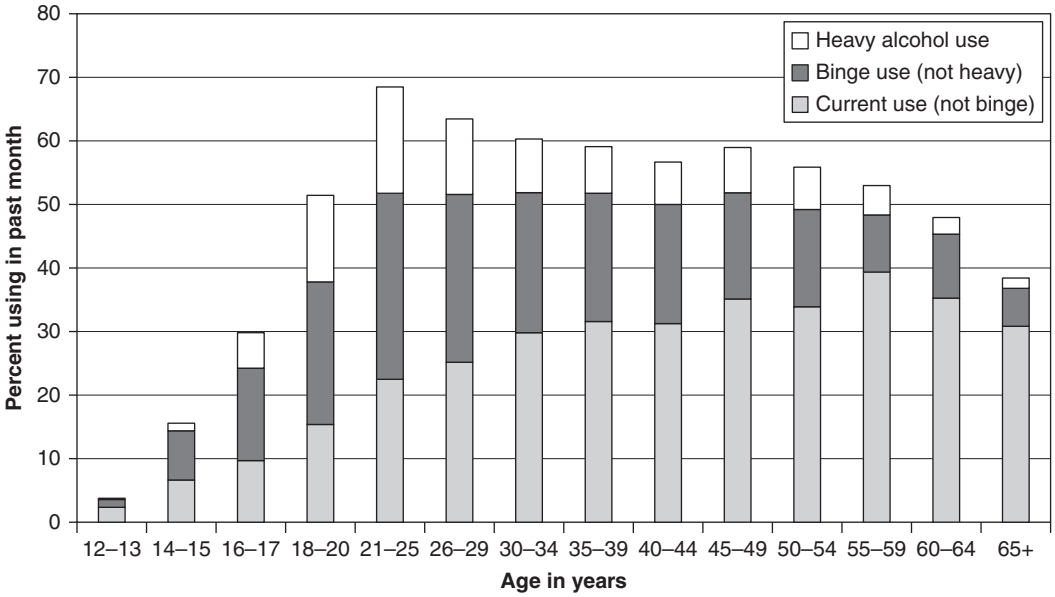

Figure 12-5 Percentage of U.S. population using alcohol in the previous month by age group, divided into heavy, binge, and nonbinge use.

Source: Substance Abuse and Mental Health Services Administration. (2006). *Results from the 2005 National Survey on Drug Use and Health: National Findings* (Office of Applied Studies, NSDUH Series H-30, DHHS Publication No. SMA 06-4194). Rockville, MD.

once in their lifetime, with 1–2% being heavy drinkers and between 14% and 24% being binge drinkers.[208]

Pregnant Women

Data averaged over 2004 and 2005 showed that alcohol consumption among pregnant women continues to be a health concern. Of those ages 15 to 44, an estimated 12.1% reported current alcohol use and 3.9% reported binge drinking. Although these rates were significantly lower than the rates for nonpregnant women in the same age group (53.1% and 23.3%, respectively), binge drinking rates for 2001–2003 were approximately 2%.[209] Heavy alcohol use was relatively rare (0.7%) among pregnant women.[1]

Race/Ethnicity

Among the population age 12 or older, whites in 2005 were more likely than other racial/ethnic groups in the United States to report current use of alcohol (56.5%). Other current alcohol use rates were 42.6% for Hispanics, 42.4% for American Indians or Alaska Natives, 40.8% for blacks, 38.1% for Asians, and 37.3% for Native Hawaiians or Other Pacific Islanders. With respect to binge drinking, the rate was lowest among Asians (12.7%). Rates for other racial/ethnic groups were 20.3% for blacks, 23.4% for whites, 23.7% for Hispanics, 25.7% for Native Hawaiians or Other Pacific Islanders, and 32.8% for American Indians or Alaska Natives.[1]

Among the underage population, ages 12 to 20, past month alcohol use rates were 12.0% among Native Hawaiians or Other Pacific Islanders, 15.5% among Asians, 19.0% among blacks, 21.7% among American Indians or Alaska Natives, 25.9% among Hispanics, and 32.3% among whites. Binge drinking in the same group was reported by 22.3% of whites, 18.1% of American Indians or Alaska Natives, and 17.9% of Hispanics, but only by 7.4% of Asians, 8.4% of Native Hawaiians or Other Pacific Islanders, and 9.1% of blacks.[1] When compared with white men, both Hispanic and black men have higher rates of mortality from cirrhosis of the liver, which is very commonly alcohol-related. However, all groups see treatment as an appropriate intervention to address alcohol problems, and there also is support for prevention.[210]

Education

Among adults age 18 or older, the rate of past month alcohol use increased with increasing levels of education.

Among adults with less than a high school education, 36.7% were current drinkers in 2005, significantly lower than the 69.4% of college graduates who were current drinkers. However, among adults age 26 or older, binge and heavy alcohol use rates were slightly lower among college graduates (18.9% and 4.9%, respectively) than among adults who had not completed college (21.9% vs. 6.0%, respectively).

Past month alcohol use was reported by 64.4% of full-time college students compared with 53.2% of people ages 18 to 22 who were not enrolled full time. Binge and heavy use rates for college students were 44.8% and 19.5%, respectively, compared with 38.3% and 13.0%, respectively, for 18- to 22-year-olds not enrolled full time in college. These patterns have remained consistent since 2002.[1]

Employment

Rates of current alcohol use in 2005 were 63.2% for full-time employed adults age 18 or older, higher than the 56.5% rate for unemployed adults. However, the pattern was different for heavy alcohol use; the rate of heavy alcohol use was higher for unemployed persons (10.4%) than for full-time employed persons (8.4%). There was no significant difference in the rates of binge alcohol use between unemployed adults and adults employed full time. Most binge and heavy alcohol users were employed in 2005. Among 52.6 million adult binge drinkers, 42.1 million (80.0%) were employed either full or part time. Among 15.4 million heavy drinkers, 12.5 million (80.8%) were employed.[1]

Geographic Area

The rate of past month alcohol use for people age 12 or older in 2005 was lower in the Southeastern United States (47.8%) than in the Northeast (55.0%), Midwest (55.0%), or West (52.5%). This pattern has remained unchanged since 2002, but the gap between the Southeastern and the other regions may be closing because the Southeastern was the only region to show a significant increase in its current alcohol use rate between 2004 and 2005. The rate of past month alcohol use in the South in 2004 was 45.1%. Similarly, for underage respondents current alcohol use rates were lower in the South (26.4%) than in the Northeast (31.4%) and Midwest (31.0%). Rates in the West were relatively low (26.0%). This pattern of use has remained essentially unchanged since 2002.[1]

Among people age 12 or older, the rate of past month alcohol use, binge drinking, and heavy alcohol use are the same or higher in large metropolitan areas (54.4%, 22.3%, and 6.1%, respectively) than in small metropolitan areas (51.4%, 23.7%, and 7.4%, respectively) and nonmetropolitan areas (44.2%, 21.9%, and 6.7%, respectively). When assessing underage drinking, it was found that current alcohol use rates were similar in large metropolitan areas (27.6%), small metropolitan areas (29.5%), and nonmetropolitan areas (27.9%), but lower in rural areas (23.1%).[1]

At-Risk Populations

Individual sectors of the population are at greater risk of alcohol misuse and abuse resulting in greater potential harm, particularly children, women and minorities. These groups and their associated risk factors are discussed below.

Youth

A study examined alcohol use from pre-adolescence to mid-adolescence and determined that peer deviance, friends' encouragement of alcohol use, and being from a single-parent family were related to an increase in alcohol use rates from ages 9 to 16 years.[211] Other risk factors of alcohol abuse included parental alcohol use, family alcohol problems, family cohesion, and peer alcohol use. Being female and higher levels of parental alcohol use were associated with higher initial rates of alcohol use.[211] Although widely reported, the evidence is still unclear for the effects of parental alcoholism. For instance, in one study, family history of alcoholism was found not to be highly correlated to underage drinking; however, paternal antisocial personality disorder was found to influence adolescent drinking.[212] Yet in another study, a pattern of behavior was identified; paternal alcoholism significantly predicted youth hostility, which predicted risk taking, which in turn significantly predicted the frequency of drinking to get drunk or high.[213]

Suicide ranks as the third leading cause of death for teenagers between the ages of 15 and 24 years, and is associated with depression and alcohol use early in school years.[214] The seventh and eighth grades, when most youth are 13 or 14, are peak years for the initiation of drinking,[215] but initiation may be more related to pubertal stage than absolute age or grade level.[216] Alcohol advertisements on television propagate valued personal attributes (i.e., sociability, elegance, and physical

attractiveness) and suggest desirable effects such as success, relaxation, romance, and adventure. Thus, alcohol advertising may not only influence adolescents to become enamored with drinking, but also may confound an already serious problem. Both the average volume of consumed alcohol and the pattern of drinking behavior independently influence alcohol-related problems among high school students[217] and should be assessed when screening patients for abuse.

Women

Study findings suggest that women metabolize alcohol less efficiently than men, a difference that leads to higher blood alcohol concentrations in women over a shorter period of time. This difference may make women more vulnerable than men to alcohol-induced liver damage.[218,219] Alcohol-related problems more prominent for women than men include serious reproductive and sexual dysfunctions, such as menstrual disorders; reduced fertility and early menopause[220–224]; more serious liver disease[225,226]; victimization by others, particularly spouses; and sexual victimization.[227]

A woman's substance abuse was demonstrated to correlate with her partner's substance abuse and the degree of emotional support provided by the partner.[228] Even though the time between the onset of drinking-related problems and entry into treatment is shorter for women than for men,[229,230] women may suffer greater physiological impairment earlier in their drinking careers, even if they consume less alcohol than men.[231,232] Female alcoholics have death rates 50% to 100% higher than those of male alcoholics. Furthermore, a greater percentage of female alcoholics die from suicide, alcohol-related accidents, circulatory disorders, and cirrhosis of the liver.[233,234]

Minorities

Liver cirrhosis represents a progressive and often fatal disease customarily associated with long-term heavy drinking. Deaths from both chronic liver disease and cirrhosis are about four times more prevalent among American Indians/Alaska Natives than among the general U.S. population,[235] which has generally been attributed to elevated levels of alcohol consumption. However, Hispanics are approximately twice as likely as whites to die from cirrhosis,[236] despite a lower prevalence of drinking and heavy drinking.[237] Interestingly, Hispanics tend to consume alcohol in higher quantities per drinking occasion (binge drinking), resulting in a higher cumulative dose of alcohol[237]; they also have a higher prevalence than whites of hepatitis C, greatly increasing the risk for liver damage in heavy drinkers.[238] Patterns of alcohol use and its consequences vary widely among minority groups. Evidence suggests that prevention and treatment efforts may be more effective when based on an understanding of the ethnic context of drinking behaviors and their development.[239,240]

Health Effects of Alcohol

Alcohol abuse is the third leading preventable cause of death in the United States. Due to the direct relationship between binge/heavy drinking and increased risk for cirrhosis, cancer, heart disease, injury, and depression, public health efforts have focused on reducing these patterns of alcohol use. The health effects of alcohol use/abuse can be direct, such as with liver cirrhosis, or indirect, as in alcohol-related motor vehicle accidents. The regular consumption of large amounts of alcohol (more than three drinks per day) is undesirable from the standpoint of health for almost all people; however, consumption of low to moderate amounts can have beneficial effects, depending on individual characteristics.[241,242] Chronic alcoholism is associated with risk factors such as poor nutrition, liver disease, malabsorption, vitamin D deficiency, hypogonadism, hemosiderosis, parathyroid dysfunction, and tobacco use. Moderate wine drinkers appear to be at lower risk of becoming heavy and excessive drinkers, and this may help explain the reported beverage-specific differences in morbidity and mortality.[249]

From 1985 to 1992, the economic cost of alcoholism and alcohol-related problems rose 42% to $148 billion,[227,243] and was $185 billion in 1998.[244] Two thirds of the costs were related to lost productivity, due to either alcohol-related illness (45.7%) or premature death (21.2%). On average, untreated alcoholics incur general health care costs at least 100% higher than those of nonalcoholics, and this disparity may exist as long as 10 years before entry into treatment. Although there are fewer deaths from alcohol-related causes than from cancer or heart disease, alcohol-related deaths tend to occur at much younger ages.[227] The remaining costs were in the form of health care expenditures to treat alcohol use disorders and the medical consequences, costs of alcohol-related motor vehicle crashes, and costs of alcohol-related crime.[244] Many violent crimes, including rape, sexual assaults, and robbery, involve alcohol use by the offender. Total violent crimes have decreased since 1998, as has the percentage of these crimes

committed while under the influence of alcohol. Based on victim reports, in 1998 37% of rapes and sexual assaults involved alcohol use by the offender, whereas 15.6% did in 2005. Similarly, 15% of robberies were committed under the influence of alcohol in 1998 compared to 10.5% in 2005.[245,246]

Liver Disease

A strong correlation exists between death rates from liver cirrhosis and drinking levels nationwide.[236] Heavy and chronic drinking is the single most important cause of illness and death from alcoholic hepatitis and cirrhosis, and can harm virtually every organ and system in the body. In 2004, liver cirrhosis was the 12th leading cause of death in the United States, and 47.5% of cirrhosis cases were alcohol related. From 1970 to 2004, the age-adjusted death rate from all liver cirrhosis declined by 48.3%; the rate for alcohol-related liver cirrhosis declined by 34.9%.[247,248] A number of factors may have contributed to this decline, including increased participation in alcohol treatment programs, decreases in alcohol consumption, and changes in the consumption of certain types of alcoholic beverages.[248]

Cardiovascular Disease

Heavy and chronic drinking is associated with cardiovascular diseases such as cardiomyopathy, hypertension, arrhythmias, and stroke.[250–252] In a group of male Veterans Administration (VA) patients presenting with chest pain, alcoholism was associated with left ventricular dysfunction, but a lower incidence and a lesser severity of angiographically defined coronary artery disease.[253] Whereas heavy alcohol consumption can have toxic effects resulting in heart failure, low to moderate alcohol consumption may be protective against the risk of heart failure,[254–257] possibly by decreasing platelet aggregation,[258] increasing fibrinolytic activity,[259] increasing high density lipoprotein levels,[260] lowering blood pressure,[261,262] or promoting neurohormonal changes preventing the onset of heart failure.[263,264]

Pancreatitis

Alcoholic pancreatitis is a major complication of alcohol abuse leading to progressive fibrosis that presents with severe abdominal pain and may result in exocrine and/or endocrine insufficiency at later stages. It has been estimated that heavy and chronic drinking contributes to between 60% and 90% of all cases of pancreatitis.[265] Cofactors contributing to chronic pancreatitis include cigarette smoking,[266] hypertriglyceridemia,[267] and genetic mutations.[268]

Driving Under the Influence of Alcohol

In the United States, alcohol-related motor vehicle crashes kill someone every 31 minutes and nonfatally injure someone every 2 minutes.[269] It is illegal to drive with a blood alcohol concentration (BAC) of 0.08% or higher in all 50 states, the District of Columbia, and Puerto Rico. Each year, alcohol-related crashes in the United States cost about $51 billion.[270] Nearly 40% of all traffic fatalities (the leading cause of accidental death) are alcohol-related,[271] and alcoholics are nearly five times more likely than others to die in motor vehicle crashes.[227] Among motorcycle drivers killed in fatal crashes, 30% have BACs of 0.08% or greater. Nearly half of the alcohol-impaired motorcyclists killed each year are age 40 or older, and those 40 to 44 years have the highest percentage of alcohol-related fatalities.[272]

In 2005, an estimated 13% of the population age 12 or older drove under the influence of alcohol at least once in the past year; however, this percentage was a decrease from 14.2% in 2002. Driving under the influence of alcohol also was associated with age, as would be expected due to the availability of alcohol. An estimated 8.3% of 16- to 17-year-olds, 19.8% of 18- to 20-year-olds, and 27.9% of 21- to 25-year-olds reported driving under the influence of alcohol in the past year. Beyond age 25, these rates show a general decline with increasing age.

Furthermore, 21% of all traffic fatalities among children ages 0 to 14 years involved alcohol,[271] and more than half of those who died in alcohol-related crashes were riding with a driver who had been drinking.[269] In that same year, nearly 1.4 million drivers were arrested for driving under the influence of alcohol or narcotics,[246] representing less than 1% of the 159 million self-reported episodes of alcohol-impaired driving among U.S. adults each year.[273] Male drivers involved in fatal motor vehicle crashes are almost twice as likely as female drivers to be intoxicated with a BAC of 0.08% or greater.[269] In fact, young men ages 18 to 20 (under the legal drinking age) reported driving while impaired more frequently than any other age group.[205,273] At all levels of blood alcohol concentration, the risk of being involved in a crash is greater for young people than for older people.[274] A shocking example of this is that in 2005, 16% of drivers ages 16 to 20 who died in motor vehicle crashes had been drinking alcohol.[269]

Fetal Alcohol Spectrum Disorders (FASDs)

A range of disorders, known as *fetal alcohol spectrum disorders (FASDs)*, result from maternal ingestion of alcohol, a known teratogen, during pregnancy. FASD is a broad term describing the range of effects seen in individuals whose mothers consumed alcohol during their pregnancies. One of the most well-known and severe effects of drinking alcohol during pregnancy is *fetal alcohol syndrome (FAS)*, which was first described and named in 1973.[275] Consumption of alcohol during pregnancy may result in physical and mental disabilities characterized by abnormal facial features, growth deficiencies, and central nervous system problems. Common signs of FAS include impaired learning, memory, attention span, communication, vision, hearing, or a combination of these. FAS is one of the leading known preventable causes of mental retardation and birth defects.[276]

FAS is the most severe of the FASDs. Other conditions in which individuals have some of the clinical signs of FAS include alcohol-related neurodevelopmental disorder (ARND) and alcohol-related birth defects (ARBD). Children with ARND typically have functional or mental problems linked to prenatal alcohol exposure, including behavioral abnormalities, cognitive abnormalities, or both. Children with ARBD tend to have anatomical abnormalities including problems with the heart, kidneys, bones, and/or hearing. All FASDs are completely preventable.[277] Simply put, a woman should not drink alcohol while she is pregnant.

The reported rates of FAS vary widely, depending on the population studied and the surveillance methods used. CDC studies show FAS rates ranging from 0.2 to 1.5 per 1000 live births in different areas of the United States.[277] Other FASDs are believed to occur approximately three times as often as FAS. In February 2005, the U.S. Surgeon General issued an Advisory on Alcohol Use in Pregnancy to raise public awareness about this important health concern. To reduce prenatal alcohol exposure, prevention efforts should target not only pregnant women who are currently drinking, but also women who could become pregnant, are drinking at high-risk levels, and are having unprotected sex.

Other Health Effects

Bone Density

Bone density, particularly at the femoral neck and spine, appears to be increased with moderate[278] or heavy[279–281] alcohol use. Liver disease may[282] or may not[283] induce bone density changes. Thus, in chronic alcoholics, it is difficult to distinguish the role of liver disease from that of alcohol itself in bone alterations. One study showed that the bone mineral density (BMD) of Ward's triangle and the trochanter of the femur were significantly lower in alcoholics than in control subjects, but a significant inverse correlation was noted between the lumbar spine BMD and the total amount of alcohol consumed.[284]

Cancer

Heavy and chronic drinking increases risk for cancer, with an estimated 2–4% of all cancer cases thought to be caused either directly or indirectly by alcohol. The strongest link between alcohol and cancer involves cancers of the upper digestive tract, including the esophagus, the mouth, the pharynx, and the larynx.[285] Less consistent data link alcohol consumption and cancers of the liver, breast, and colon.[285,286] Hepatic cirrhosis is the most common precursor to hepatocellular carcinoma, the eighth most frequent cancer in the world, accounting for approximately 500,000 deaths per year. Unlike many malignancies, hepatocellular carcinoma occurs predominantly within the context of known risk factors, including alcohol abuse.[287] A recent study examined a cohort of more than 140,000 European men and found no causative link between alcohol consumption and prostate cancer, supporting most of the existing literature on the subject.[288]

Immune System/Infectious Disease

Heavy and chronic drinking depresses the immune system and results in a predisposition to infectious diseases, including but not limited to respiratory infections, pneumonia, and tuberculosis. Chronic alcoholism in the absence of liver disease is associated with increased secretion of inflammatory cytokines by peripheral blood dendritic cells,[289] inhibited antigen presentation by monocytes,[290] and impaired dendritic cell differentiation.[291] Exact abnormalities may depend on both the status of alcohol intake and the existence of alcoholic liver disease.[292] In both males and females, alcohol exposure suppresses immune responses, particularly natural killer cells[293]; however, it is unclear whether there are significant gender differences in this suppression. Chronic exposure to alcohol alters the production of this same set of hormones (i.e., estrogen and testosterone), and hence alcohol's effects on immunity could involve an indirect mechanism in which alcohol alters hormone levels and, in turn, the hormones regulate immune responses.[294]

Sexually Transmitted Disease

An association has been established in both homosexual and heterosexual populations among alcohol use, drug use, and behavior that increases the risk for contracting HIV and other sexually transmitted diseases. Underlying processes and mechanisms that explain this relationship has not been definitively identified, however.[227]

Unintentional Deaths and Injuries

Alcohol was involved in 39% of all boating fatalities in 2002, an increase of 5% from 2001.[295] Furthermore, estimates suggest that alcohol is associated with 47–65% of adult drownings[227] and up to 40% of industrial fatalities and 47% of industrial injuries.[296]

Alcoholics are 16 times more likely than others to die in falls, and 10 times more likely to become fire or burn victims.[227] A recent analysis of over 9000 autopsies found fatal falls down stairs to be entirely attributable to either an underlying severe disease causing the fall (i.e., severe coronary artery disease, myocardial infarction, or brain tumor) or alcohol influence.[297]

Although violence-related injuries are associated with a drinking pattern (i.e., binge drinking or heavy drinking), meta-analysis of these types of injuries shows that the association is even greater simply with the act of drinking. Thus, many injuries are not due to the actions of chronic alcoholics, but the impaired judgment of anyone who drinks.[298,299]

Intervention and Counseling

In 2006, 19.5 million people 12 years or older needed treatment for an alcohol use problem, representing 7.9% of people in that age group. Only 1.6 million received alcohol use treatment at a specialty facility; of the remaining 18 million people who did not receive treatment, only 541,000 (3.0%) felt they needed treatment for their alcohol use problem. Of the 19.5 million, 1.4 million were youth ages 12–17, which is 5.5% of the population of that age group. In 2006, only 101,000 youth received treatment at a facility, leaving 1.3 million youth without treatment.[300]

Primary Prevention

Economic, social, political, and environmental forces work together to perpetuate alcohol-related problems, and are not likely to be reduced by strategies involving single interventions directed solely at the individual. Some measures that have been shown to be effective in preventing injuries and deaths from impaired driving include sobriety checkpoints,[301] aggressively enforcing existing 0.08% BAC laws, minimum legal drinking age laws, and zero tolerance laws for drivers younger than 21 years old in all states.[205,273,302] Prompt suspension of the driver's licenses of people who drive while intoxicated is both effective[303] and warranted, because those drivers involved in fatal crashes with BAC levels of 0.08% or higher were nine times more likely to have a prior conviction for driving while impaired than were drivers who had not consumed alcohol.[269] Community-based approaches to alcohol control and prevention of driving under the influence (DUI), including mass media campaigns and school-based education programs[302–307] and mandatory substance abuse assessment and treatment for DUI offenders,[308] have also shared some success.

Price increases on alcoholic beverages may be especially effective at reducing addictive consumption by younger, poorer, and less educated consumers, but the long-term health impacts of drinking may have a greater effect on addictive consumption by older, richer, and more educated consumers.[227] Evidence indicates the price control via taxation could be effective and may reduce alcohol consumption and alcohol-related problems.[309,310] In fact, some studies concluded that doubling the federal tax on liquor in the United States would reduce the cirrhosis mortality rate by at least 20%.[311,312]

In some communities, particularly those with a high proportion of at-risk populations, alcohol prohibition or restrictions have some positive outcomes. For example, prohibiting the sale, importation, and possession of alcohol by adults and adolescents (i.e., dry communities) in remote Alaska Native communities has shown decreased total[313] and alcohol-involved[314] injury-related death rates and decreased alcohol-related outpatient visits.[315] Analysis of illegal sales of alcohol to youth directly relates to frequency of youth alcohol use, binge drinking, use of alcohol at school, and drinking and driving. Further, communities with greater minor-in-possession enforcement have lower rates of alcohol use and binge drinking.[316] Regarding adults, restricting the sale of alcohol in at-risk communities, rather than prohibiting it, has also been shown to be effective.[314,317]

School-based prevention programs that are designed to focus on social influences, such as peer resistance training or attempts to change perceived norms about alcohol, show more promise for changing alcohol use patterns when compared to programs that emphasize the development of personal capabilities such as

self-esteem, skill in making decisions and solving problems, and understanding how alcohol use can interfere with personal values and goals.[227] Other programs that show promise are those that have been modified to be more culturally relevant for specific ethnic groups. For example, the school-based Life Skills Training (LST) program was designed to help adolescents cope with social influences that encourage use of alcohol and other drugs. Participation in either the standard LST program or the modified version based on both the traditional and current cultural heritages of African American and Hispanic inner-city youth demonstrated significant decreases in alcohol consumption, with significantly greater improvement using the culturally focused approach.[239]

Secondary Prevention

A systemic review and meta-analysis found that screening may not be reproducible and bias by the physician may influence reported outcomes of intervention, calling into question the practice of screening in general practice.[318] Although studies have independently shown good sensitivity and specificity for many screening methods,[319–321] others have found particular questionnaires to perform adequately only in subpopulations,[322–325] which may be related to the proficiency of the screener.[319,326] Three of the most commonly used screening instruments are CAGE, TWEAK, and AUDIT.

Screening patients is only effective if at-risk patients receive subsequent intervention. For example, a randomized controlled trial found reduced alcohol consumption levels and emergency room visits in alcohol-misusing patients who were screened and referred to follow-up care.[327] One study used CAGE-based questions to identify patients at risk for alcohol abuse, subsequently recommended intervention, and showed that at 6-month follow-up these patients consumed less alcohol per occasion and per week.[328] The simple CAGE screen is:

- *C:* Have you ever felt you ought to *cut down* on your drinking?
- *A:* Have people *annoyed* you by criticizing your drinking?
- *G:* Have you ever felt bad or *guilty* about your drinking?
- *E:* Have you ever had a drink first thing in the morning (*eye opener*) to steady your nerves or get rid of a hangover?

Despite some loss in sensitivity and specificity, the TWEAK, in its original or modified forms, can be extended to measures of high-risk drinking that incorporate infrequent heavy intake and can be used to test for moderate- as well as high-risk drinking.[329] The TWEAK questions may be optimal to identify women with alcohol abuse or dependence in ethnically diverse populations. The TWEAK instrument is:

- *Tolerance:* How many drinks does it take before you feel the first effects of alcohol?
- *Worried:* Have close friends or family worried or complained about your drinking in the past year?
- *Eye openers:* Do you sometimes take a drink in the morning when you first get up?
- *Amnesia:* Has a friend or family member told you about things you said or did while you were drinking that you could not remember?
- *Cut down:* Do you sometimes feel the need to cut down on your drinking?

AUDIT performs best in screening for problematic alcohol use among under-age drinkers,[330,331] including those in treatment in emergency departments.[331] Because of the scoring system, the AUDIT screening tool may be particularly relevant for defensive patients in situations where alcohol-specific questions cannot be asked with confidence. **Table 12-2** shows the AUDIT questionnaire.

Tertiary Prevention

A study examining the relative cost effectiveness of 33 specific treatment modalities for alcoholism suggested that more costly treatments are not necessarily more effective; of the six treatment modalities classified as having "good evidence of effect," all appear in the minimal-, low-, or medium-low-cost categories.[227] Some cost-effective modalities include the following:

- Twelve-step self-help programs, which appear to produce positive outcomes in many of its members,[332] although their efficacy in randomized clinical trials is not well established[333]
- Motivational enhancement therapy, which may be one of the most cost-effective of available treatment methods[334]
- Couples therapy, in which involvement of a nonalcoholic spouse can improve patient participation rates and increase the likelihood that the patient will alter drinking behavior after treatment ends[335]
- Brief intervention to reduce drinking, alcohol-related problems, and patients' use of health care services[336,337]

Table 12-2 AUDIT Questionnaire

Question	Score 0	1	2	3	4
1. How often do you have a drink containing alcohol?	Never	Monthly or less	2–4 times a month	2–3 times a week	≥4 times a week
2. How many drinks containing alcohol do you have on a typical day when you are drinking?	1–2	3–4	5–6	7–9	≥10
3. How often do you have 6 or more drinks on one occasion?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
4. How often during the last year have you found that you were not able to stop drinking once you had started?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
5. How often during the last year have you failed to do what was normally expected of you because of drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
7. How often during the last year have you had a feeling of guilt or remorse after drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
8. How often during the last year have you been unable to remember what happened the night before because of your drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
9. Have you or someone else been injured because of your drinking?	No		Yes, but not in the last year		Yes, during the last year
10. Has a relative, friend, doctor, or other health care worker been concerned about your drinking or suggested you cut down?	No		Yes, but not in the last year		Yes, during the last year

A score of 8 or more suggests harmful or hazardous drinking over the past year.

Alcohol-dependent patients are encouraged to enter specialized treatment with the goal of complete abstinence. Providing heavy drinkers who are not alcohol-dependent with self-help materials relating to alcoholism can, by itself, be an effective method of brief intervention.[227]

DRUGS

Abuse of both licit and illicit drugs has detrimental effects not only on health, but on economies as well. Here is a discussion of who, what and why drugs are abused, adverse public health effects and finally treatment strategies.

Statistics and Trends

Psychoactive drugs are drugs that affect the central nervous system inducing calming, energizing, or pleasurable responses. The results of legal restrictions on the production and distribution of psychoactive substances range from nonexistent (e.g., caffeine) to highly restricted (e.g., lysergic acid diethylamide [LSD]). For controlled substances, drug abuse is defined as use in a nonprescribed manner, whereas for noncontrolled substances, drug abuse should be considered continued use in the face of recurrent adverse consequences. For instance, any use of LSD would be considered abuse, whereas only excessive use of alcohol would be termed abuse. Finally, drug dependence refers to "a state of psychic or physical dependence, or both, on a drug, arising in a person following administration of that drug on a periodic or continuous basis."[338] Drug dependence can include (1) physical dependence, which is identified by intense physical disturbances when the drug is no longer used; (2) psychological dependence, in which consumption of the substance produces pleasure or avoids discomfort, resulting in a feeling of satisfaction and psychic drive; and/or (3) tolerance, a physiologic response requiring higher doses of a drug to achieve the original effect of the drug.[338]

Drug Classes of Public Health Concern

Prescription and Over-the-Counter Drugs

The purpose of both prescription and over-the-counter drugs are to foster health and minimize symptoms of discomfort and ill health. Abuse of these drugs is often complicated by several factors. These drugs are used for self-medication; patient compliance may become ambiguous, so it is difficult to monitor who, exactly, has access to prescribed or purchased drugs. In addition, prescribing practices are influenced by differences in medical education, practice norms, and pharmaceutical marketing approaches. Thus, the major public health concerns about these types of drugs are related to both prescribing practices and Food and Drug Administration (FDA) monitoring of drugs.

Banned Substances

Banned substances are those that appear on the Schedule list of the FDA, as defined under the Controlled Substances Act of 1970.[339] There are five classes of drugs (Schedule I to V) based on abuse, dependence, and medical use. The medicinal value of these drugs is limited, and they are generally obtained for recreational use. A few of the most prevalent banned substances include marijuana, cocaine, morphine, LSD, and phencyclidine (PCP). Although there is debate about these drugs' medicinal value, particularly marijuana, avoiding these drugs is important for promoting health and a healthy lifestyle.

Alternative Medicines

Alternative medicines include vitamins and herbs. Sale of these remedies has increased substantially over the past 20 years. Even though the FDA lobbied Congress in 1993 to regulate these medicines, the Dietary Supplement and Health Education Act of 1994 resulted in the declaration that herbal remedies are "supplements" and exempt from FDA investigation.[340] Thus, manufacturers of these plant products are exempt from testing these products for efficacy or quality control. This is of concern because for many products, safe upper limits and toxicity have not been established.

Prevalence

In 2005, an estimated 19.7 million Americans age 12 or older were current (past month) illicit drug users, representing 8.1% of the population of that age. This rate is similar to the rates of recent years, including 2004 (7.9%), 2003 (8.2%), and 2002 (8.3%). Trends in the use of each of the major illicit drugs has remained stable during the period 2002–2005 (**Figure 12-6**).[1]

Based on the most recent statistics, marijuana is the most commonly used illicit drug, used by 74.2% of drug abusers. Among all illicit drug abusers, 54.5% used only marijuana, 19.6% used marijuana and another illicit

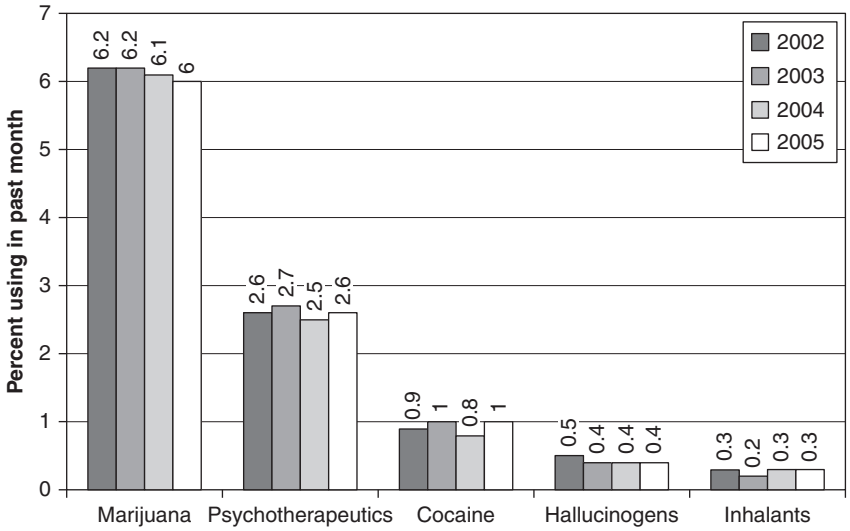

Figure 12-6 Trends in the use of each of the major illicit drugs during the period 2002–2005.

Source: Substance Abuse and Mental Health Services Administration. (2006). *Results from the 2005 National Survey on Drug Use and Health: National Findings* (Office of Applied Studies, NSDUH Series H-30, DHHS Publication No. SMA 06-4194). Rockville, MD.

drug, and the remaining 25.8% used only an illicit drug other than marijuana.[1] In 2005, among past year marijuana abusers age 12 or older, 13.3% used marijuana on 300 or more days within the past 12 months. This translates into 3.4 million people using marijuana on a daily, or almost daily, basis. Among past month marijuana abusers age 12 or older, 34.8% (5.1 million) used the drug on 20 or more days in the past month. On a positive note, the percentage of adolescent marijuana abusers who used on 20 or more days in the past month declined from 28.1% in 2004 to 23.1% in 2005.[1]

Although methamphetamine use among the household population has remained fairly stable between 2002 and 2007 (0.7–0.8%), methamphetamine-related admissions to hospitals and treatment facilities continue to rise.[341–343] According to the most recent Methamphetamine Threat Assessment, methamphetamine is reported as one of the top two greatest drug threats in six of the nine U.S. regions, demonstrating that the drug is continuing to spread to new parts of the country.[344] Prescription drug abuse is also of broad national concern, with over 10% of high school seniors nationally reporting nonprescription abuse of Vicodin in the past year and 5% reporting nonprescription abuse of OxyContin.[345]

Abuse of so-called "club drugs" such as GHB (gamma hydroxybutyrate), ketamine, LSD, and MDMA (methylenedioxymethamphetamine/ecstasy) appears to have peaked. The availability and demand for these drugs are generally very low and are decreasing. MDMA abuse, in particular, continues to decrease after a surge in abuse in the late 1990s and early 2000s.[343,344] All available national-level data regarding MDMA availability (seizure, arrest, and law enforcement survey data) and MDMA demand (National Survey on Drug Use and Health [NSDUH] and Maintaining the Future [MTF] data) strongly indicate that availability and use of the drug peaked in 2001 and decreased consistently and significantly through 2005, particularly among 12th graders where abuse was most prevalent (decreasing from 9.2% to 3.0%).[343,344] In fact, from 2001 to 2004 the number of MDMA-related arrests decreased 53% and the number of seized MDMA samples tested by the Drug Enforcement Administration (DEA) decreased 85%.[346]

The trafficking and abuse of GHB and LSD are at low levels and are only a moderate concern because the consumption of these drugs is limited and distribution is controlled primarily by small-scale, independent producers and distributors. Availability of GHB has decreased since 2000 to relatively low levels in most

areas, and even the number of GHB samples seized and tested by the DEA decreased 94% from 2000 to 2005. National-level data regarding LSD availability and demand also show a sharp decrease since 2000. LSD seizures and arrests, for example, decreased from 2000 through 2004.[344] In fact, MTF and NSDUH data show that rates of past year abuse for LSD have decreased significantly for nearly every sampled age group.[346]

Mono- vs. Poly-Drug Abuse Patterns

In 2002, the Department of Health and Human Services found that 56% of all admissions to publicly funded treatment facilities were for multiple substances: alcohol, marijuana, cocaine, opiates, and others, in order of prevalence.[347] Alcohol abusers often report abuse of other substances, with some reports claiming that 68–80% of the alcoholics in treatment may be dependent on at least one other substance.[348,349] The converse is also true; alcohol abuse has been noted for those admitted for dependence on illicit drugs.[349] A recent study looked at 7 years of admissions (1998–2004) at publicly funded facilities and found alcohol, marijuana, and cocaine to be the substance of choice to abuse either alone or in combination.[350]

Demographics

Age

Rates of drug abuse are associated with age, peaking among 18 to 20 year olds (22.3%) (**Figure 12-7**). In total, in 2005, 9.9% of youth ages 12 to 17 were current illicit drug users, with marijuana being the drug of choice, followed by prescription-type drugs, inhalants, hallucinogens, and cocaine.[1] Youth marijuana prevalence rates have been declining in the United States[351] and in other Western countries in recent years.[345,352]

Different age groups engage in the use of different types of illicit drugs. Among 12- or 13-year-olds, 1.7% abused prescription-type drugs nonmedically, 1.5% abused inhalants, and 0.9% abused marijuana. Among 14- to 15-year-olds and 16- to 17-year-olds, marijuana is the dominant drug abused (5.9% and 13.6%, respectively), followed by prescription-type drugs and inhalants. In addition to these drugs, 16- to 17-year-olds also become exposed to hallucinogens and cocaine in significant numbers.[1]

Gender

As in previous years, adult males were more likely in 2005 to report current illicit drug abuse than adult females

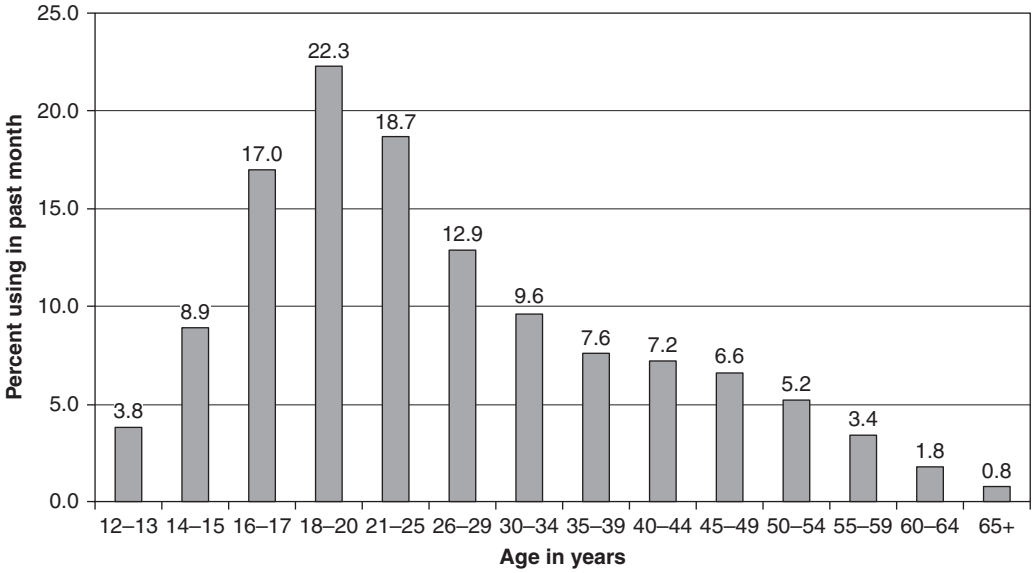

Figure 12-7 Percentage of U.S. population abusing licit or illicit drugs in the previous month by drug, 2002–2005.

Source: National Survey on Drug Use and Health.

(10.2% vs. 6.1%) and were about twice as likely to abuse marijuana (8.2% vs. 4.0%). However, the rates of nonmedical abuse of prescription-type psychotherapeutics were similar for both genders (2.8% vs. 2.5%). Among adolescents ages 12 to 17, the rate of illicit drug abuse was similar for males and females (10.1% vs. 9.7%). Males had a slightly higher rate of marijuana abuse than females, but the rate for prescription-type psychotherapeutics was similar. On a positive note, however, marijuana abuse significantly declined since 2002 for both male (9.1% to 7.5%) and female youth (7.2% to 6.2%).[1,351]

Pregnant Women

Using combined data from 2004–2005, 3.9% of pregnant women ages 15 to 44 years reported using illicit drugs, which is significantly lower than the rate among women ages 15 to 44 who were not pregnant (9.9%). There are no significant differences from the 2002–2003 combined rate.[1]

Race/Ethnicity

Current illicit drug abuse is reported for different races/ethnicities. The rate in 2005 was lowest among Asians (3.1%) and highest for American Indians or Alaska Natives (12.8%). Other rates were 9.7% for blacks, 8.7% for Hawaiians/Pacific Islanders, 8.1% for whites, and 7.6% for Hispanics. Although marijuana abuse has remained relatively stable since 1991 with a recent period of decline, significant increases were seen in young black men and women. Additionally, marijuana abuse disorders among marijuana abusers significantly increased even in the absence of increased frequency and quantity of marijuana abuse, suggesting that increased potency may be responsible.[353]

Among youth ages 12 to 17 in 2005, the rate of current illicit drug abuse was highest among American Indians or Alaska Natives, about twice the overall rate among youth (19.2% vs. 9.9%). There were no statistically significant changes between 2004 and 2005 in the rate of current illicit drug abuse for any racial/ethnic subgroup among persons age 12 or older.[1]

Education

Illicit drug abuse in 2005 was also associated with educational status. Among adults age 18 or older, the rate of current illicit drug abuse was lower among college graduates (5.0%) compared with those who did not graduate from high school (9.8%), high school graduates (8.6%), and those with some college (8.9%). The rate of current illicit drug abuse among full-time college students (21.2%) was similar to the college-age 18- to 26-year-old population (21.8%). Statistically, there was a significant increase in methamphetamine abuse among full-time college students ages 18 to 22, from 0.2% in 2004 to 0.5% in 2005. However, the rate was relatively stable among others in that age group (1.0% in 2004 vs. 0.8% in 2005).[1]

Employment

Current employment status was also associated with illicit drug abuse in 2005. Among unemployed adults, 17.1% were current illicit drug abusers, compared to full-time (8.2%) and part-time (10.4%) employed adults. These rates were all similar to the corresponding rates in 2004.[1]

Geographic Area

The rate of current illicit drug abuse in metropolitan areas in 2005 was higher than the rate in nonmetropolitan areas. The rates were 8.4% in both large and small metropolitan counties and 6.9% in nonmetropolitan counties as a group. Within nonmetropolitan areas, counties that were urbanized had a rate of 7.8%, less urbanized counties had a rate of 6.5%, and completely rural counties had a rate of 5.1%.[1]

At-Risk Populations

The "gateway" hypothesis asserts that consumption of abusable drugs causally progresses through discrete stages beginning with beer or wine and moving progressively through hard liquor or tobacco, to marijuana, and finally to hard drugs.[354,355] The evidence for this theory is controversial. In one study marijuana was the first drug used by 42% of sample delinquent youth,[356] but in other studies 29%,[357] 39%,[358] and 75%[359] of hard drug abusers began using marijuana after they had used hard drugs. Thus, the abuse of illicit drugs, whether or not preceded by licit drug use, may be explained by the common liability model in which availability in the social environment and individual propensity for all abusable substances explain the abuse of illicit drugs.[360]

Models of etiology and prevention of drug abuse include dozens of risk factors of various origins including genetic,[361–364] neurophysiological,[365,366] neurochemical,[367,368] and behavioral,[369,370] many of which apply

specifically to youth. Some of the most often identified risk factors include:

- Drug abuse by a family member, particularly a parent[371,372]
- Disruptive early family experiences[373–375] including sexual abuse[376]
- Early drug use,[373,377] but maybe not prescription drug use[378]
- Association with peers who use[371]
- Sensation seeking[379]
- Depression[373,380] or bipolar disorder[381]
- Deviance[382,383]
- Hyperactivity[384]
- Low self-esteem[373,384]
- Low socioeconomic status[375,385]

A number of studies have assessed the relative value of each of these factors, but because drug use is a personal experience, a complex picture emerges when generalizations of populations are made.

Although infrequent, the gateway progression to illicit and addictive drugs is the most common pattern of drug progression. In an effort to tease out which factors and variables were associated with this drug progression, a study compared youth who used alcohol and/or tobacco and those who also subsequently abused marijuana. Of 35 variables associated with substance use, delinquency appeared to be the only variable of significant difference and magnitude.[386]

College Students

Drug abuse in the college age group is highest, estimated to be 22.3% among 18- to 20-year-olds (**Figure 12-7**), whether they are in college or not. In a study of 4580 undergraduate students, nearly 6% reported using illicit prescription stimulants in the past year, with women being more likely than men to report using the drugs to lose weight (18.2% vs. 3.2%), help study, and increase alertness. Conversely, males were more likely to report their use for experimentation and to counteract the effects of other drugs.[387] In a related study, it was found that the majority of nonmedical abusers of prescription stimulants are polydrug users. The authors concluded that this subclass of drug user should be screened for other potential drug abuse and dependence, especially those who report non-oral routes of administration.[388]

Adolescents

Approximately one out of every five secondary students in a study of nearly 1100 reported nonmedical abuse of prescription drugs. Further, a higher frequency of prescription drug abuse among teenagers ages 12–18 has a positive correlation with drug abuse or dependence.[389]

Low Socioeconomic Status

Neighborhood poverty has been shown to be associated directly with current drug abuse. In one study, the odds of reporting heroin, crack, and/or cocaine abuse in the past year were 52% higher in neighborhoods where at least one third of the residents were living in poverty.[385] Additionally, drug influences in the personal network also are associated with drug abuse.[371] Having a network of social support and having ties to employed people was protective of current drug abuse, but could not protect against the effects of neighborhood poverty in the face of negative drug influences in the social network.[375,385]

Health Effects of Drugs

Abuse of illicit substances manifests as a significant public health issue. Drug-related complications and injuries contribute approximately $12 billion per year to our national health care bill and represent a significant contributing factor to our nation's mortality toll through injury, overdose, sexually transmitted diseases and infections, and liver and cardiovascular diseases.[390] Self-reported health in healthy young adults declines with increased and/or chronic drug abuse, and may be partly mediated by persistent tobacco use.[391] Other significant social consequences of drug abuse include productivity loss, increased crime and imprisonment, and mental and physical disability.[390,392] As might be expected, negative consequences are more probable and more severe with abuse of more highly addictive substances such as heroin and cocaine, as opposed to marijuana.[393,394]

Accidents, Injuries, and Overdose

Injuries to both self and others are a concern with the abuse of illicit drugs. A disproportionate number of drug abusers are adolescents. Although not widely appreciated, evidence suggests that some drugs previously thought not to be associated with fatalities are in fact deadly, including GHB. Accident, homicide, and suicide are the three leading causes of death among adolescents,[395] and drug abuse has been implicated in more than half of these deaths.[396] Furthermore, self-injury in adolescence may be associated with substance use and is considered to be a risk factor predicting future illicit

drug abuse.[397] In 2005, 10.5 million people age 12 or older (4.3% of that age population) reported driving under the influence of an illicit drug during the past year.[1] Drugs other than alcohol, specifically marijuana and cocaine, are involved in about 18% of motor vehicle driver deaths. However, these other drugs are generally used in combination with alcohol.[398]

Sexually Transmitted Diseases and Blood-Borne Pathogens

Stimulant abuse is associated with increased risk of contracting HIV. In addition to the risk of contracting HIV through sharing contaminated needles, the risk of contracting HIV is increased in noninjection drug abusers as well,[399] possibly due to increased sexual activity.[400] A recent study conducted in the United Kingdom found that, most frequently, sexual activity after drug use occurred even though the individual hadn't taken the substance for the specific purpose of sex. Intravenous users of methylphenidate, a cocaine-like substance, and cocaine abusers report significantly increased sexual desire in comparison to control subjects.[401] Risky sexual behavior during drug intoxication, particularly alcohol, cannabis, cocaine, and ecstasy, may contribute to observed increases in sexually transmitted diseases among drug users by lowering sexual inhibitions and increasing self-esteem and confidence.[400,402–404]

From a public health perspective, past and current injection drug use (IDU) is important in the epidemiology of blood-borne pathogens, including the HIV virus and hepatitis B and C viruses. Because chronic asymptomatic infections can lead to severe illnesses years after infection,[405–407] former users remain at risk long after they quit. In one survey, approximately half of the hepatitis C–infected participants admitted to using drugs intravenously. Most were former users and at least 35 years old.[408] In addition, prevalence of abuse is inversely related to both income and educational level.[409] Analysis of 17 National Household Survey on Drug Abuse surveys from 1979–2002 revealed that the mean age of injection drug users has increased substantially from 21 to 36 years, and that from 2000–2002, about 60% of those who had ever used injection drugs were ages 35–49 years. This demonstrates that the people born between the late 1940s and early 1960s have had, and still have, the highest prevalence of intravenous drug use.[409]

Liver Disease and Pancreatitis

Hepatotoxicity represents a potential complication from the usage of various illicit drugs, possibly consequent to their liver metabolism; however, information on this is scarce in the medical literature. Chronic marijuana usage, on its own or in association with either crack cocaine or alcohol, has been associated with hepatic morphologic and enzymatic alterations. These findings indicate that cannabinoids may be hepatotoxic substances.

Medication-induced pancreatitis is a rare type of the disease, accounting for about 2% of all cases.[410] Almost all of these are due to licit drug use; however, a rarer cause cited in the literature is illicit drug abuse, specifically tetrahydrocannbinol (THC) from cannabis. A probable overdose was the cause of the first reported case,[411] but three additional cases were recently reported, two possibly dose-related and the other due to chronic abuse.[412] Drug abusers may also be at increased risk for metabolic syndrome due to disrupted cellular metabolism.[413]

Cardiovascular Disease

Cocaine abuse may result in a variety of cardiovascular complications, including but not limited to myocardial infarction, arterial thrombosis, coronary dissection, and cardiomyopathy. Cocaine-induced aortic dissection is fairly rare, but may be involved in as many as 10% of acute cases.[414] Marijuana abuse was not independently associated with cardiovascular risk factors, but it was associated with other unhealthy behaviors, such as high caloric diet, tobacco smoking, and other illicit drug abuse, which all have long-term detrimental effects on health and cardiovascular disease.[415]

Clinical and experimental evidence suggests that methamphetamine can have adverse and potentially fatal effects on the cardiovascular system. The existing literature suggests that methamphetamine abusers are at elevated risk of chronic cardiac pathology regardless of the duration of abuse, but the risk is greatest among chronic methamphetamine abusers.[416] A comprehensive review assessed physical and psychological health effects of methamphetamine abuse and found that although psychosis is given prominence in the public debate, this and similar drugs cause serious heart disease, leading to dependence and high rates of suicidal behavior.[417]

Intervention and Counseling

Primary Prevention

The 2008 National Drug Control Strategy proposed a balanced approach to reducing drug use within the United States by emphasizing three primary objectives:

stopping use before it starts, healing America's drug users, and disrupting illicit drug markets. However, the main focus of drug legislation in the United States is to cut off supply to drug users. Domestic law enforcement, interdiction, and international programs represent 65.2% of the requested budget for the 2009 fiscal year, 6.1% higher than the 2008 budget. Treatment and prevention programs represent 34.8% of the total budget, declining 1.5% over the last fiscal year.[351]

It has been argued that a more effective and cost-effective way of influencing the U.S. cocaine market involves targeting treatment of hard core abusers.[418] This is because initiation rates in the United States are no longer growing, and are actually declining; however, consumption remains high because of heavy and dependent abusers, representing a relatively large fraction of total users. Heroin and marijuana are in similar episodic stages (new initiation is low), but data from treatment facilities and emergency rooms show that dependent abuse is still a problem. Initial use is on the rise for both methamphetamine and prescription drug abuse, so prevention and enforcement policies may still be a cost-effective approach.[419,420]

Disrupting the black market for prescription drugs requires a different approach than that typically used for the other illicit substances, and there is minimal research on which to guide this. However, the proposals put forth in the 2008 National Drug Control Strategy, such as improved domestic intelligence, a crackdown on Internet sales of prescription drugs, and assisting pharmacies with abuse-resistant drugs and capsules, are reasonable approaches to pursue. In the case of methamphetamines, research shows that federal regulation of precursor chemicals used in their production decreases the societal harms associated with use.[421,422] Pharmacists can play an important role in preventing drug abuse, because they are the contact point with the public. They need to be well-informed about addiction issues and be prepared to screen, assess, and refer individual cases, and collaborate with physicians caring for chemically dependent patients.[423]

Anti-drug campaigns have had mixed results, but school-based drug prevention curricula may be more effective.[418,424] A multi-year evaluation of the National Youth Anti-Drug Campaign found that it had no impact on marijuana abuse among youth.[425,426] However, a randomized study found that there were synergistic effects of exposure to the campaign combined with the ALERT Plus classroom-based drug prevention curriculum compared to either program alone.[427] These results showed that weekly exposure to anti-drug media messages had a statistically significant deterrent effect on past month marijuana abuse, consistent with other studies that have evaluated the impact of anti-tobacco and anti-drug media messages.[428–431] A private enterprise, Psychometrics Technologies, Inc., has launched an eight-module school-based curriculum that claims to incorporate several successful prevention strategies and has shown successful reduction of drug and alcohol use at 6-month follow-up.[432] In addition to diminishing substance abuse among youth, some studies show that particular programs have demonstrated improvements in general academic performance.[433,434] The effectiveness of random drug testing in schools is far from conclusive.[435] The two most notable studies draw completely different conclusions, and the question of whether this approach works remains unanswered.[436,437]

Secondary Prevention

In contrast to the large number of useful, validated, and practical screening instruments for alcohol abuse, relatively few have been developed for detecting drug abuse. Expanding the CAGE questions by adding the phrase "or drug use" to each of the four questions increased the instrument's sensitivity for identifying drug abuse.[438] However, the Drug Abuse Screening Test (DAST) is one of the most widely used screening tests for drug abuse and addiction due to its brevity (20 questions), ease of administration, and yes/no simplicity (**Table 12-3**).[439]

Tertiary Prevention

In 2006, 7.8 million people age 12 or older needed treatment for an illicit drug abuse problem. Of these, only 1.6 million (20.3%) received treatment at a specialty facility at some time during the previous year. The number of people needing treatment has remained relatively stable each year for the preceding 5 years: 2002 (7.7 million), 2003 (7.3 million), 2004 (8.1 million), and 2005 (7.6 million), with a similar proportion getting treatment each year.[300] Interestingly, of those who needed but did not receive treatment for illicit drug abuse in 2006, only 8.0% reported that they perceived a need for treatment, and just over one third of that 8% reported that they made an effort to get treatment.[300]

The need for treatment is even more pronounced among youth ages 12 to 17–1.2 million youth (4.8% of the population that age) needed treatment for an illicit drug abuse problem in 2006. Of this group, only

Table 12-3 DAST Screening Questions

1. Have you used drugs other than those required for medical reasons?
2. Have you abused prescription drugs?
3. Do you abuse more than one drug at a time?
4. Can you get through the week without using drugs?
5. Are you always able to stop using drugs when you want to?
6. Have you had "blackouts" or "flashbacks" as a result of drug use?
7. Do you ever feel bad or guilty about your drug use?
8. Does your spouse (or parents) ever complain about your involvement with drugs?
9. Has drug abuse created problems between you and your spouse or your parents?
10. Have you lost friends because of your use of drugs?
11. Have you neglected your family because of your use of drugs?
12. Have you been in trouble at work because of your use of drugs?
13. Have you lost a job because of drug abuse?
14. Have you gotten into fights when under the influence of drugs?
15. Have you engaged in illegal activities in order to obtain drugs?
16. Have you been arrested for possession of illegal drugs?
17. Have you ever experienced withdrawal symptoms (felt sick) when you stopped taking drugs?
18. Have you had medical problems as a result of your drug use (e.g., memory loss, hepatitis, convulsions, bleeding, etc.)?
19. Have you gone to anyone for help for a drug problem?
20. Have you been involved in a treatment program especially related to drug use?

Scoring: 0, No abuse 1–5, Low level of abuse 6–10, Moderate level of abuse 11–15, Substantial level of abuse 16–20, Severe level of abuse.

Source: National Findings Developed by Harvey Skinner, PhD. University of Toronto.

136,000 received treatment at a specialty facility (11.2% of youth ages 12 to 17 who needed treatment), leaving behind 1.1 million youth who needed treatment but did not receive it. The six most often reported reasons for not receiving treatment were (1) no health coverage and unaffordable cost (35.1%), (2) not ready to stop using (31.8%), (3) not knowing where to go for treatment (14.7%), (4) concern that getting treatment might cause neighbors/community to have negative opinion (13.5%), (5) possible negative effect on job (12.8%), and (6) being able to handle the problem without treatment (12.4%).[300] It is estimated that 5-16% of cocaine abusers are cocaine dependent within the first 2 years of use, defined by the American Psychiatric Association's Diagnostic and Statistical Manuals (DSM)-IIIR classification.[377,440,441,442] These numbers are higher than for cannabis and alcohol dependence, each estimated to be between 1-4%.[440]

CHIROPRACTIC INVOLVEMENT

All health care providers should be concerned with patient tobacco, alcohol, and drug abuse. The U.S. Preventive Services Taskforce, CDC, and Healthy People 2010 guidelines all encourage providers to counsel substance abusers on cessation.[56,443,444] Furthermore, the U.S. Public Health Service and Institute for Clinical Systems Improvement recommend that physicians determine and document tobacco use and ETS exposure at every office visit.[172,445] The literature supports these policies; a meta-analysis of nine studies found that clinicians who inquired about smoking status were approximately three times more likely to introduce a smoking cessation intervention.[443] In fact, educating interns at a chiropractic college on giving advice on smoking cessation increased nearly eight-fold the chances that smoking patients would receive information.[446]

Health care providers, particularly those in complementary and alternative medicine (CAM), such as chiropractors, can make significant contributions to a patient's quality of life. This is due in large part to the holistic patient-centered approach offered by these practitioners. Chiropractors are ideally suited to address this public health concern, especially because smoking rates among general practice patients may be higher than in random community samples, and the majority is reported to be willing to receive advice about smoking cessation.[447]

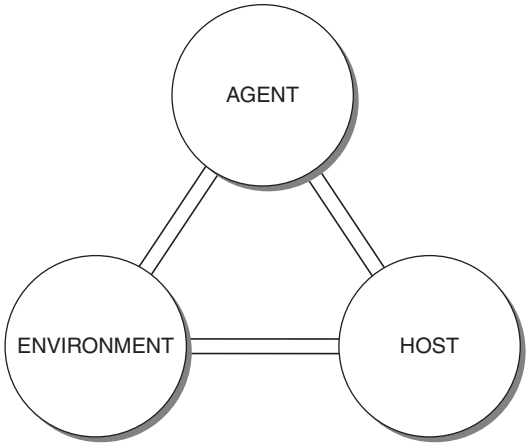

Figure 12-8 The most frequently used and accepted health promotion model for public health.

The Health Promotion Model for Substance Abuse

The model most frequently used and accepted for public health embodies the triangular interaction among the agent, the environment, and the host (**Figure 12-8**).[448] Health promotion issues dealing with the agent (drug) include regulations on the places that distribute or sell the drug, taxation, and general availability. The environment includes the immediate surroundings, such as the school or workplace, and associated people like parents, siblings, and peers. It is important to remember, however, that the environment is much larger than that, and includes all forms of media and advertising, such as the Internet, billboards, and TV. Public health measures focus a sizeable amount of resources on school-based programs and ad campaigns that address the environmental aspect of drug abuse. The host is the individual. Most health promotion efforts are directed toward the individual. For instance, in designing a campaign, the creators should plan to address individuals who are at high risk. Early detection efforts, such as drug testing in schools, are directed toward populations most likely to be susceptible to subsequent intervention.

Advice to Clinicians

The doctor should first ask all patients whether they smoke, drink, or abuse legal or illegal drugs, regardless of the patient's age or sex. **Table 12-4** lists some examples of important questions to ask your patient. Familiarity with smoking cessation guidelines is associated with better delivery of tobacco cessation counseling to adolescents.[449] The physician must realize that all smokers are at increased risk of developing ischemic heart disease (i.e., myocardial infarction, stroke, peripheral vascular disease) and chronic obstructive lung disease and have increased risk of lung, esophageal, oral, bladder, cervical, and pancreatic cancers. Chronic heavy drinkers are at elevated risk for liver disease, cardiovascular disease, and pancreatitis. Drug abusers are at particular risk for heart disease. Most importantly, the physician should ultimately encourage abstinence in all populations. Additionally, physicians should emphasize to their patients who are pregnant or those with established coronary artery disease or chronic obstructive lung disease that they should quit smoking because the associated morbidity is higher in these groups.

After a patient has been identified as a substance user, the physician should assess the level of dependence using either qualitative or quantitative methods. One of the newest instruments is the World Health Organization's Alcohol, Smoking and Substance Involvement Screening Test (ASSIST). As its name suggests, it is a comprehensive instrument designed to identify psychoactive substance use in individuals who use a number of substances and have varying degrees of substance use. The validity of this instrument was recently demonstrated in a multi-site international study by comparing the results against eight other valid exams, including the DAST, the AUDIT, and the Revised Fagerstrom Tolerance Questionnaire (RTQ).[450]

The following five steps are based in part on the recommendations from the National Institute on Alcohol Abuse and Alcoholism (NIAAA) *Physicians' Guide*,[451] and the Public Health Services *Clinical Practice Guidelines*,[443]

Table 12-4 Sample History Questions to Ask About Substance Use

Minimum Questions to Ask Your Patient	Rationale
Do you smoke (use any tobacco product), drink, or use illicit drugs?	All health care providers need to be proactive about smoking.
If tobacco, what product?	Different types of tobacco are associated with different diseases/cancers.
How much?	Provides a baseline from which to improve.
Have you ever used more/less?	Identifies recent attempts and the stage of readiness-to-change.
When?	
What made you change the frequency?	Opportunity to provide guidance.
Are you planning on quitting?	Identifies readiness-to-change to give proper advice.
When?	

but they are appropriate as a guide to developing a treatment plan for patients with substance abuse issues (**Table 12-5**).

1. *Ask:* Ask each patient about substance abuse. Simple questions, such as "Do you smoke or drink?" and "Do you use any drugs?" are generally sufficient. If the answer is yes to either question, follow up with appropriate questions. The CAGE or modified CAGE questions are a good screening device, particularly if supplemented with questions about frequency and quantity, such as the first three AUDIT questions. Determine the maximum amount of substance that is used on one occasion, the frequency of heavy use, and the frequency of light use. CAGE, TWEAK, and DAST questions are designed to elicit this information. Also assess possible substance abuse consequences on medical, social, employment, or legal issues. Simply asking the right questions may help patients gain an appreciation for the seriousness of their situation. In addition to quantity, frequency, and severity, assess the patient's readiness to change. This helps the physician determine their approach to the patient.
2. *Advise:* Conduct a brief intervention, and set appropriate and realistic goals. Negotiate with the patient to involve them in the decision-making process. If the patient insists on continuing at an unsatisfactory level, accept their decision, but leave the door open to further discussion. Of course, abstinence is the best goal for substance abusers. Although referral to a specialist or treatment program is indicated with substance abusers, it is the responsibility of the physician to determine whether the patient is ready for that. Temporary goals, such as reducing consumption, may often be the first steps prescribed by the physician.

Table 12-5 Questions Adapted from the Public Health Service's *Clinical Practice Guidelines* for Smoking Cessation

The 5 As For the Willing Patient	The 5 Rs For the Unwilling Patient
Ask about use.	Relevance of quitting: Encourage the patient to think about quitting.
Advise to quit.	Risks of use: Assist the patient in identifying risks.
Assess willingness to make a quit attempt.	Rewards of cessation: Assist the patient in identifying benefits of quitting.
Assist in quit attempt.	Roadblocks to quitting: Discuss potential problems with the patient.
Arrange follow-up.	Repeat: Provide motivational intervention at all visits.

3. *Assess:* Although there is a lack of clear evidence as to whether stage-based interventions are more effective than non-stage-based interventions,[452] individual studies have shown useful effects, and stage of change assessment has become part of some smoking cessation clinical practice guidelines.[443,453,454] The readiness-to-change model describes the process of quitting any substance in discrete stages: precontemplation, contemplation, and preparation. Precontemplation-stage patients include those who are not planning to stop in the next 6 months or who have no intention of stopping. These people may simply not be considering quitting, but may be open to the idea. Contemplation-stage patients include those who plan on stopping in the next 6 months, but not the next 30 days. Preparation-stage patients include those who plan on stopping in the next 30 days. Users of tobacco, alcohol, or illicit drugs in each of these stages differ in terms of outcome expectations and belief in their ability to successfully quit.

   As with tobacco and alcohol use, patients with drug problems may not be interested in changing their behavior, or even willing to discuss it. It may be helpful to recognize where the patient is along the continuum of precontemplation to contemplation to preparation, and encourage their progress to the next stage. For instance, trying to move a precontemplator into action may have unintended consequences such as increased resistance to guidance. Instead, coax the patient to achieve a realistic and attainable goal.
4. *Assist:* In addition to holding the patient accountable for their actions, provide patients with current lists of specialists or rehabilitation facilities, as necessary. In addition, be available to listen to patient concerns and discuss options. These efforts should help prevent relapse.
5. *Arrange follow-up:* Just like for patients with chronic or recurring conditions, patients participating in tobacco, alcohol, or illicit drug abuse require regular follow-up. A patient previously unwilling to accept a referral for a treatment program may be willing a few visits later. Also, a patient who experiences difficulty in adhering to a reduced consumption program may be willing to accept a new goal of abstinence. Supportive, nonjudgmental care can help maintain sobriety, but expect relapses.

If one is to provide substance cessation intervention, individualized factors for each patient should be assessed in order to provide a personal treatment plan. The presence or absence of variable factors should be determined to identify relative risk of disease and likelihood of cessation, allowing for individualized intervention and personalized follow-up. For example, the "time to first cigarette" in the morning independently predicted abstinence in one study, while waking in the night was negatively associated with abstinence.[455]

Youth Intervention Guidelines

Child health care clinicians can play an active role in treating dependence among youth. The World Health Organization (WHO) has adopted recommended guidelines for child health care clinicians to treat tobacco use and nicotine dependence among children and adolescents,[456] which has been modified to apply for all substance abuse:

- Clinicians should screen pediatric and adolescent patients and their parents for use and provide a strong message regarding the importance of totally abstaining from tobacco and drug use, and warn against providing the wrong message about alcohol use.
- Clinicians need to assess adolescent tobacco, alcohol, and drug use, and offer developmentally appropriate cessation counseling and behavioral interventions that have been shown to be effective with adults.
- Clinicians should reinforce messages delivered in community- and school-based intervention activities.
- Clinicians in a pediatric setting should offer cessation advice and interventions to parents to limit children's exposure to ETS and inappropriate drinking or drug behavior.

Common Physician Errors

Physicians have a great opportunity to address the public health issue of substance abuse; however, action is lacking. The following are some of the common mistakes made:

- *Not asking:* Many primary care physicians do not document the substance use status of their patients. It may be easiest to delegate this responsibility to a member of the staff—for

example, as part of assessing vital signs—to ensure this gets done.

- *Not offering cessation advice:* Less than half of smokers report that their primary care physicians advised them on smoking cessation, and approximately half of those receive advice upon every visit. Assuming it takes only 2 minutes to offer cessation advice, and approximately 25% of patients are smokers, a doctor seeing 30 patients a day would spend a total of 15 minutes counseling patients on smoking over the entire day.
- *Forgetting to follow up:* Most relapses occur within the first month of cessation. Patients during this time are most vulnerable and require follow-up from their physicians to maximize their chances of success.
- *Giving up too early:* Often multiple attempts are required to be successful in quitting. Explain that persistence and patience are required, but do not over-encourage your patient to quit before they are ready.
- *Not referring:* Specialists and rehabilitation facilities are available for every abusable substance. Keep lists handy and use them liberally. In lieu of referral, replacement aids are available to quit smoking and include nicotine patches, gum, inhalers, and sprays.

Drugless Treatments for Tobacco, Alcohol, and Drug Use

Acupuncture has been used for several decades for smoking cessation, primarily acting to reduce withdrawal symptoms by enabling the body to produce endogenous endorphins.[457,458] Using traditional acupuncture meridians, research using repetitive low-level laser therapy may be promising in reducing withdrawal symptoms to help with smoking cessation. Physical activity has also been shown to be effective for reducing tobacco withdrawal symptoms and cravings, as well as reducing post-cessation weight gain.[459]

Currently, there is no specific behavioral or psychosocial therapy that consistently demonstrates treatment benefits for cocaine dependence.[460] The limited success has led patients and physicians to examine alternative therapies, including acupuncture, which is a common treatment option for the treatment of addictions, such as alcohol, nicotine, and drug dependence,[461] although the efficacy of acupuncture for cocaine dependence is in question.[462]

CONCLUSION

Training of interns at medical and chiropractic colleges in the area of smoking cessation is woefully deficient.[463–466] Chiropractors see approximately 30% of back pain patients each year,[467,468] and among those with chronic conditions, smoking is often the top comorbidity reported.[469] It has been reported that CAM practitioners may be the most appropriate for delivery of health promotion messages because they are already seen by patients as holistic and lean in philosophy toward prevention[470]; however, CAM practitioners may not be taking advantage of this opportunity. An investigation of nine chiropractic teaching clinics in the United States found that less than 40% of patients who smoke were advised on quitting and less than 20% received advice and materials from interns.[466]

Drug abuse and addiction are very complex and they need to be treated as such. Drug abusers need to be treated as a "whole person," meaning many aspects need to be addressed in practice. They may need help in performing their daily activities, emotional support from family and friends, spiritual guidance, and professional assistance. Start a conversation with your patients, be inviting, and if dealing with a young patient, try to excuse the parent from the conversation if possible. Ask about mood, friends, and if they are doing anything new to "get an edge" in school or to alleviate stress.

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CHAPTER
13

Pediatrics in Public Health

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CHAPTER OUTLINE

It is probably reasonable to assume that the great majority of chiropractors regularly treat pediatric patients in the course of their professional life. In fact, the percentage of chiropractic practice represented by the pediatric population group is escalating, particularly in the past two decades, as parents seek solutions to their children's health problems outside of mainstream western or allopathic medicine.[1,2] As the chiropractic profession matures and begins to adopt an increasingly responsible attitude toward public health promotion and disease prevention, our professional posture necessarily needs to move more and more towards integration into the wider health care fraternity.[3] With this philosophical and ethical mindset, much opportunity exists for the chiropractor to add materially to the health and well-being of the pediatric population as well as of their local communities. In the course of daily practice, and in community education, today's chiropractor has a vital role to play. What follows in this chapter is designed to empower local chiropractors in private practice to step into that role.

THE ROLE OF THE CHIROPRACTOR IN DEVELOPMENTAL SURVEILLANCE

The concept of developmental surveillance as a means to identify affected or at-risk children at an early age, thereby creating the opportunity to employ interventional strategies to affect eventual outcome, has been part of community medicine for many decades now. The concept was first formally organized by Dr. Arnold Gesell, who founded and developed the Clinic of Child Development at Yale University. Gesell followed Freudian concepts, studying development from the biological and behavioral perspectives,[4] an orientation that gave rise to a unimodal model focusing on single biological or environmental factors that cause developmental delay—the so-called *main effect model*. This approach has been found to be very limiting, and over time has given way to a more dynamic approach referred to as the *transactional model*, which postulates that developmental outcomes are the end result of a complex transaction between intrinsic or within-child factors (e.g., genes, central nervous system development, temperament) and environmental factors (e.g., parenting style, amount of stimulation, socioeconomic status).[5]

In recent years this concept has been the subject of increasing numbers of research investigations seeking to answer the question of whether it is an effective strategy. Some investigators, partly because of low sensitivity values recorded for the surveillance techniques, have concluded that surveillance by general practitioners and community nurses is not useful in identifying health issues at an early enough stage to instigate effective intervention.[6–8] Others, however, while acknowledging the shortfalls of current surveillance techniques, have warned that reducing such services will adversely affect the health of a proportion of children who would otherwise have been identified as having a health care need.[9] Still others have suggested that developmental surveillance can be performed with high sensitivity and carries worthwhile potential to positively affect the outcome in adolescence and adulthood of affected and at-risk children.[10–12]

Foley and her colleagues,[5] in the preparation of their review of the early childhood literature for the Australian Department of Family and Community Services, identified seven major longitudinal studies that identified a variety of individual, familial, and community risk and protective factors for young children that are associated with differential outcomes over time. These longitudinal studies have served to highlight two important findings—first, that early childhood risk factors are associated with a wide variety of adverse outcomes, and second, that these risk factors may be in evidence in either the short or long term.

Screening childhood development would, of course, be an exercise in futility if the resulting early intervention was ineffective. Fortunately, developmental outcomes can and are being improved upon by the implementation of early intervention strategies such as involvement of the at-risk child in early childhood learning programs.[5,13] This fact alone not only makes it worthwhile to routinely screen children for developmental deviations and abnormalities, but indeed makes it a professional imperative if the chiropractic profession is to take its place responsibly in the wider health care delivery system at a community level. The question really is more how to screen, not whether to screen.

It would be fair to say that the Denver Developmental Screening Test (DDST) is the most widely used screening test in clinical pediatrics, being utilized all over the world. Special adapted versions have even been produced for specific populations such as those encountered in Asia.[14] Although it is reported to have acceptable individual test specificity (low false negative results) and therefore does not result in over-referral, the sensitivity of some of the tests remains problematic, resulting in reported under-referral in some instances. This has prompted some investigators to recommend other tests such as the Minnesota Inventories or the Battelle Developmental Inventory Screening Test.[15] In addition to these concerns, individual practitioners need to undertake extensive and costly training in order to be qualified to administer the DDST. The time element required for administration is also not cost effective for the chiropractor in the private practice setting.

The Woodside developmental screening test (WDST) is probably the system most suitable to the chiropractic private practice setting,[16] and has for many years been taught as the preferred screening protocol in both Australian and British postgraduate courses in clinical pediatrics for chiropractors. The WDST has excellent inter-examiner reliability,[17,10] a test sensitivity score better than that of the DDST, and is very quick and easy to administer, allowing the chiropractor to visualize longitudinal developmental outcome in four key areas of development—vision and fine motor skills, gross motor skills, hearing and language, and social skills.[10] A manual of individual test descriptors for the WDST is available from Kiro Kids (admin@kirokids.com.au).

The WDST utilizes a system of four charts, which together provide a visual summary of developmental progress. The horizontal axis of each chart shows the age of the child, with a range from 6 weeks to 4 years.

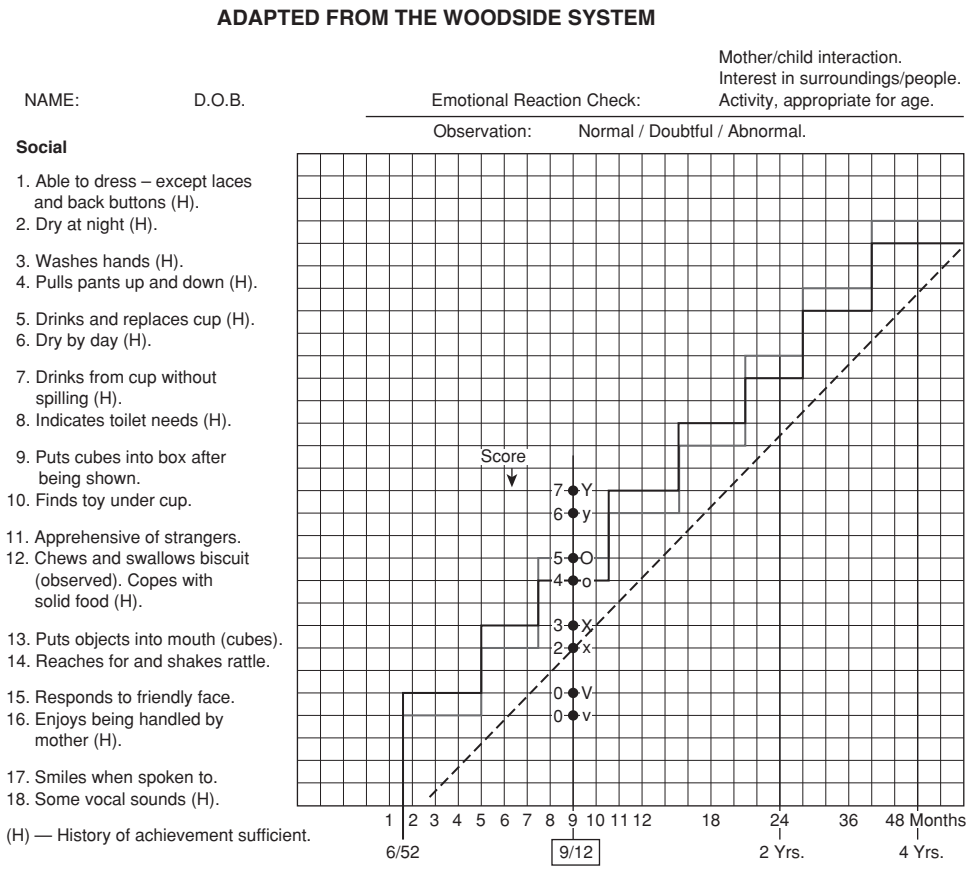

Figure 13-1 How to record a Woodside developmental assessment; in this case it is for a 9-month-old child assessed for social development.

Source: Eu BS. Evaluation of a developmental screening system for use by child health nurses. *Arch Dis Child.* 1986;61(1):34–41.

The vertical axis contains a variety of tests set out in pairs, with the pairs corresponding to appropriate ages and forming a step pattern across the chart. In each of the four charts the child's developmental achievement level is plotted against the age of the child. A minimum total of eight test items are to be applied for any individual child—that is, two test items for each of the four developmental areas. The results of the assessment are recorded on the appropriate charts, as shown in **Figure 13-1**.

Let's take the social development assessment of a 9-month-old child as an example to demonstrate how to record achievement on the chart. A mark is made on the upper level of the step if the child demonstrates appropriate achievement in both tests 11 and 12 and at the lower level of the steps if they successfully achieve only one of them. In the event the child fails to demonstrate appropriate achievement on items 11 and 12, then items 13 and 14 are assessed. These would normally be achieved successfully by a 6-month-old child. Appropriate achievement of one or both of tests 13 and 14 is scored at the appropriate level. Tests 15 and 16 are applied in the event of the child failing 13 and 14. It is not recommended that a child be scored above their chronological age even if they are able to achieve the test items because this is a screening test for delay, not for advanced ability.

If the marks on the chart fall on the age-appropriate step, the child's development in that particular area is deemed to be normal; however, if the marks lie between the step and the dotted or "threshold" line, development is considered to be doubtful. Finally, if the marks fall on or below the dotted line, development is considered to be abnormal or delayed and the patient is in need of careful neurological evaluation to determine if referral is necessary.

In her evaluation study conducted among maternal and child health nurses in South Australia, Eu[10] noted

that when the assessment plot lies on or below the dotted line in the first year of life, the child's development is delayed by approximately 3 months; in the second year it is delayed 6 months; and in the third and fourth years it is delayed 12 months.

Items marked with the letter H are assessed solely by asking parents or caregivers whether they have observed the child doing those things at home. All other items must be observed by the examiner during the course of the actual assessment.

Examples of normal, doubtful, abnormal, and fall-off progress are shown in **Figures 13-2, 13-3, 13-4**, and **13-5**. When anything other than normal progress is encountered, the WDST should be accompanied by a very detailed neurological history and examination to determine the need for referral.

THE ROLE OF THE CHIROPRACTOR IN NUTRITIONAL SURVEILLANCE

In the so-called western world, we have progressively moved further and further away from sound principles of nutrition. Packaged, processed foods have replaced natural, whole foods eaten as close to raw as possible. A good example of this is the breakfast cereals that specifically target children. A *Choice* magazine survey[18] of breakfast cereals available in supermarkets revealed that "around 70% of the kids' cereals have too little fibre to be worth recommending. Of the kids' ones that make the grade for fibre, only six aren't spoilt by being too salty or sugary." Similar observations could be made for the plethora of fast foods that are increasingly forming a regular part of the staple diet of today's child and adolescent.

The chiropractor plays a critical role in the field of pediatric nutrition. The chiropractor often meets the child and family for the first time at a point of ill health, and an opportunity to address long-standing, poor nutritional practices presents itself. Taking the opportunity to steer the child and wider family away from processed, packaged, oversalted, and sugary foods back to sound nutritional principles is a health promotion/disease prevention strategy that falls comfortably within the chiropractic paradigm of wellness. This trend toward eating less healthy foods is now so serious and so entrenched in western thinking that the potential role of the chiropractor extends far beyond those patients seen in a clinic environment to a public health responsibility. This responsibility could ostensibly include teaching parents' groups, making presentations at schools and infant health centers, and judiciously using Internet resources.

In order to take this opportunity, the chiropractor needs to be familiar with the general principles of nutritional

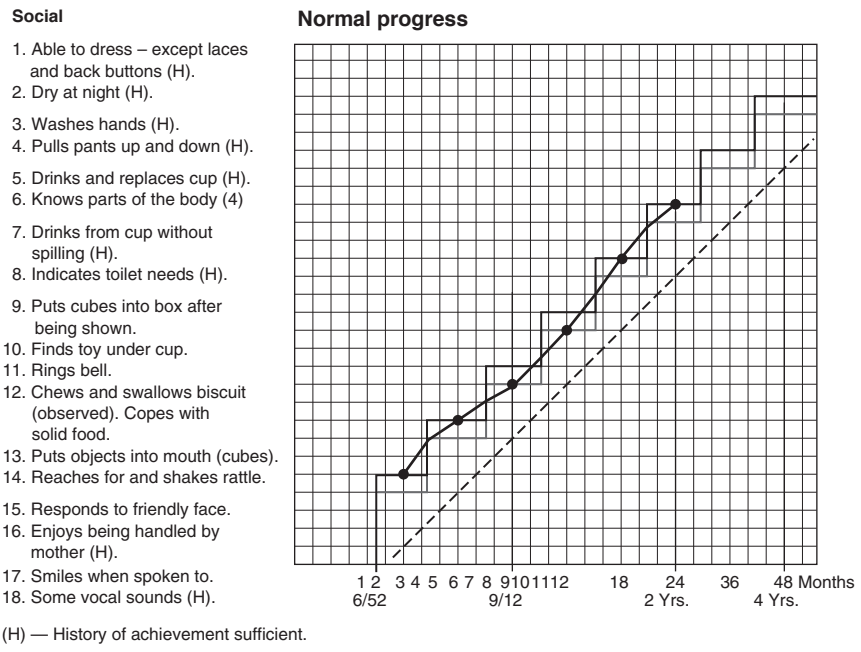

Figure 13-2 Normal progress in the social area.

Source: Eu BS. Evaluation of a developmental screening system for use by child health nurses. *Arch Dis Child.* 1986;61(1):34–41.

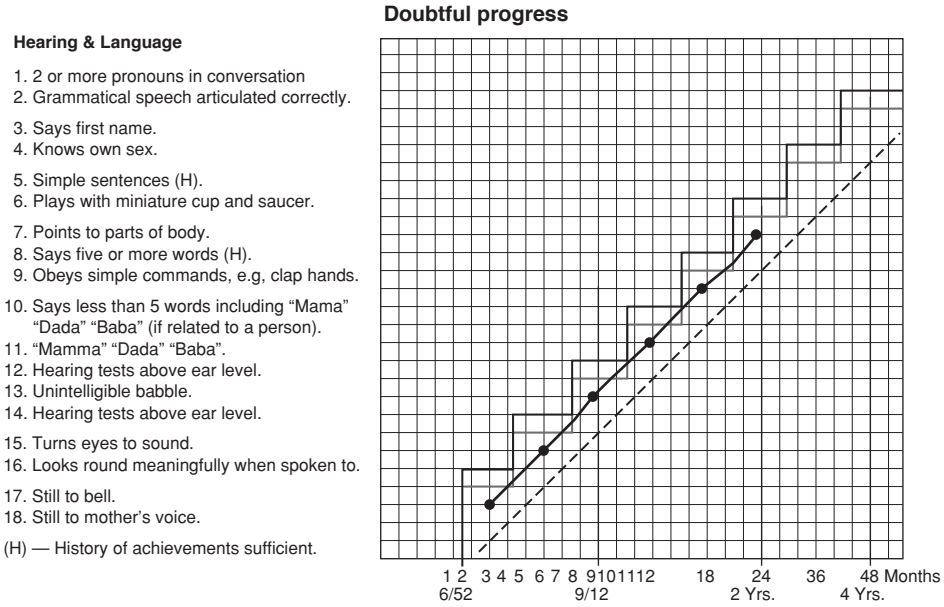

Figure 13-3 Doubtful progress in the hearing and language area.

Source: Eu BS. Evaluation of a developmental screening system for use by child health nurses. *Arch Dis Child.* 1986;61(1):34–41.

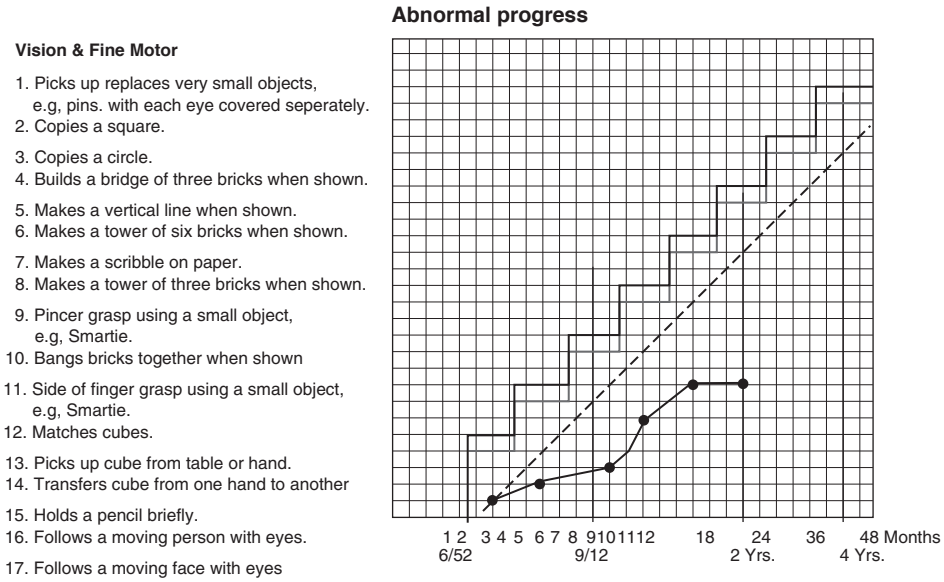

Figure 13-4 Abnormal progress in the vision and fine motor area.

Source: Eu BS. Evaluation of a developmental screening system for use by child health nurses. *Arch Dis Child.* 1986;61(1):34–41.

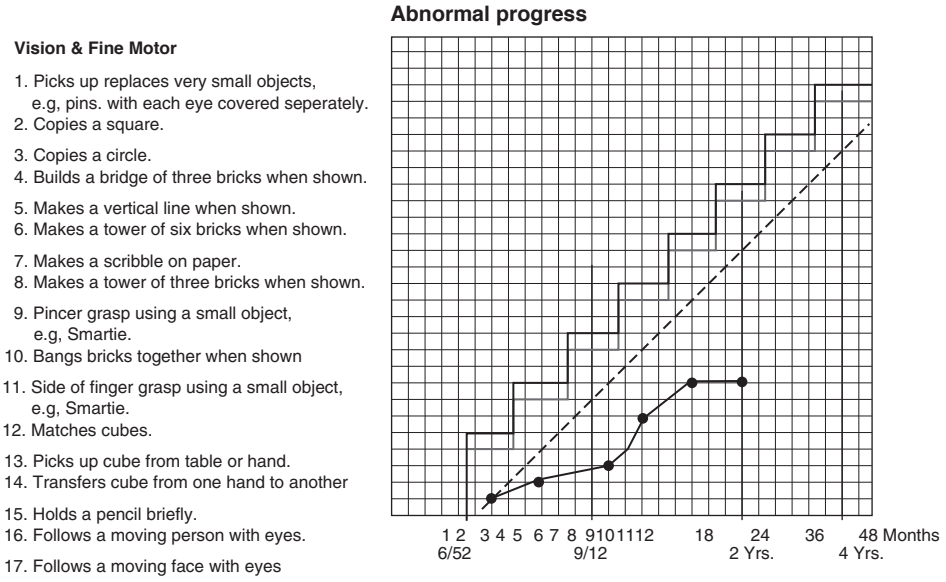

Figure 13-5 Fall-off progress in the gross motor area.

Source: Eu BS. Evaluation of a developmental screening system for use by child health nurses. *Arch Dis Child.* 1986;61(1):34–41.

practice and the fundamental strategies used to measure, assess, and advise patients accordingly. To provide patients and their families with sound, reliable information that will impact their health in the longer term, knowledge of the nutritional requirements of infants and children, best feeding practices for the various age levels in pediatrics, and techniques for collecting and assessing food intake information is needed. Familiarity with the more common disorders of metabolism and nutrition that may be encountered in chiropractic practice is also essential.

Nutritional Requirements of Infants and Children

Infants grow rapidly during their first year of life, increasing their weight threefold and their length twofold in that time. The rate of growth slows beyond the end of the first year, but still imposes a significant and unique nutritional demand. The nutrient turnover rate and higher metabolic rate of children as compared to adults, when superimposed on the need to support these rates of growth, create high maintenance needs as the clinician considers the various factors of health promotion in the child and adolescent patient. Failure to provide consistently adequate nutrition to children is also likely to affect not only growth, but also development, both somatic and organic.

Recommended (or reference) intakes of most nutrients have been established, and these appear to fulfill the unique nutritional needs of the infant and young child. These requirements are summarized for the 0- to 6-month-old infant, the 6- to 12-month-old infant, the 1- to 3-year-old child, and the 4- to 8-year-old child in **Table 13-1**.

Feeding the Child in the First Year of Life

One of the first issues that new parents are confronted with is the mode of feeding for their new baby in the first year of life. There are choices and it is helpful to provide parents with balanced information to assist them to make a best case scenario choice.

Breastfeeding or Bottle-feeding?

Infant nursing is a time-honored practice in all cultures and ages in the history of man. Breastfeeding is an unequalled way of providing ideal food for the healthy growth and development of infants; it is also an integral part of the reproductive process with important implications for the health of mothers. Human breast milk is widely accepted to be the optimal source of nutrition for the newborn infant because it contains all the proteins, lipids, carbohydrates, micronutrients, and trace elements necessary for optimal growth, development, and immune protection.

Table 13-1 Daily Reference Intake of Nutrients for Normal Infants

Nutrient	Reference Intake Per Day			
	0–6 Mo (6 kg)	7–12 Mo (9 kg)	1–3 Yr (13 kg)	4–8 Yr (22 kg)
Energy (kcal (kJ)/24 hr)*	550 (2310)	720 (3013)	1074 (4494)	–
Fat (g/24 hr)	31 (AI)	30 (AI)	–	–
Linoleic acid (g/24 hr)	4.4 (AI)	4.6 (AI)	7 (AI)	10 (AI)
-linoleic acid (g/24 hr)	0.5 (AI)	0.5 (AI)	0.7 (AI)	0.9 (AI)
Carbohydrate (g/24 hr)	60 (EAR)	95 (EAR)	130 (RDA)	130 (RDA)
Protein (g/24 hr)*	9.3 (EAR)	11 (RDA)	–	21 (RDA)
Electrolytes and Minerals				
Calcium (mg/24 hr)	210†	270†	500†	800†
Phosphorus (mg/24 hr)	100†	275†	460*	500
Magnesium (mg/24 hr)	30†	75†	80*	130*
Sodium (mg/24 hr)*	120	200	225	300
Chloride (mg/24 hr)*	180	300	350	500
Potassium (mg/24 hr)*	500	700	1000 (1 yr)	1400
Iron (mg/24 hr)	0.27†	11*	7*	10*
Zinc (mg/24 hr)	2†	3*	3*	5*
Copper (g/24 hr)	200†	220†	340*	440*
Iodine (g/24 hr)	110†	130†	90*	90*
Selenium (g/24 hr)	15†	20†	20*	30*
Manganese (mg/24 hr)	0.003†	0.6†	102†	1.5†
Fluoride (mg/24 hr)	0.01†	0.5†	0.7†	1.0†
Chromium (g/24 hr)	0.2†	5.5†	11†	15†
Molybdenum (g/24 hr)	2†	3†	17	22
Vitamins				
Vitamin A (g/24 hr)	400†	500†	300*	400*
Vitamin D (g/24 hr)	5†	5†	5†	5†
Vitamin E (mg -TE/24 hr)	4†	6†	6*	7*
Vitamin K (g/24 hr)	2.0†	2.5†	30†	55†
Vitamin C (mg/24 hr)	40†	50†	15*	25*
Thiamine (mg/24 hr)	0.2†	0.3†	0.5*	0.6*
Riboflavin (mg/24 hr)	0.3†	0.4†	0.5*	0.6*
Niacin (mg NE/24 hr)	2†	4†	6*	8*
Vitamin B_6 (g/24 hr)	0.1†	0.3†	0.5*	0.6*
Folate (g)	65†	80†	150*	200*
Vitamin B_{12} (g/24 hr)	0.4†	0.5†	0.9*	1.2*
Biotin (g/24 hr)	5†	6†	8†	12†
Pantothenic acid (mg/24 hr)	1.7†	1.8†	2†	3†
Choline (mg/24 hr)	125†	150†	200†	250†

*RDA.

†Adequate intake (e.g., for infants < 1 yr of age; this is the mean intake of normal breast-fed infants).

Source: Heird WC. *Nutritional requirements during infancy*. In: Bowman BA, Russell RM, eds. *Present Knowledge in Nutrition*. 8th ed. Washington, DC: International Life Sciences Institute (ILSI) Press; 2001:416–425. Reproduced with permission.

The importance of breast milk and its superiority as a source of infant nutrition is highlighted in the recent overhaul of the World Health Organization growth charts that are now based on exclusively breastfed infants. As a global public health recommendation, infants should be exclusively breastfed for the first 6 months of life to achieve optimal growth, development, and health.[19] In Australia, the 2001 National Health Survey showed that

87% of infants between 0 and 3 years of age had at some stage obtained nutrition from breast milk—a similar figure to that identified in the 1995 survey (86%).[20]

Breastfeeding should be initiated as soon after the birth of the child as possible, depending, of course, on the infant's ability to tolerate enteral nutrition. Putting the newborn baby to the breast immediately postpartum facilitates the delivery of the placenta because the sucking of the areola stimulates the release of the nanopeptide hormone oxytocin from the adenohypophysis of the pituitary gland, which in turn causes myometrial contractions of the uterine wall.[21]

Breastfeeding in the immediate postpartum period also fosters mother–infant bonding,[22,23] with oxytocin levels having been shown to be critical in the promotion of successful bonding.[24] Breastfeeding in the first hours of life also plays a role in maintaining normal metabolism as the baby progresses from fetal to extra-uterine life. Breastfeeding has demonstrated long-term benefits for the overall health of the infant, providing a reduced risk of the development of serious disorders. For example, infants who have been breastfed for a period in excess of 6 months have been shown to be less likely to develop autistic disorder than their counterparts who were artificially fed infant formula without docosahexaenoic acid/arachidonic acid supplementation.[25] Breastfeeding also has been shown to play a significant role in the prevention of conditions such as obesity; gastrointestinal diseases[26]; childhood cancers, including leukemia[27]; bedwetting[28]; and the later development of asthma and allergies.[29]

It is axiomatic, therefore, that mothers should be encouraged and supported in their efforts to commence nursing their newborn infants as soon after delivery as possible. In the words of one young mother when asked why she breastfed,

> I breastfeed because it is how human females were designed to nurture their young. I breastfeed because it allows me precious close time with my daughter. I breastfeed because it ensures my daughter is getting optimum nutrition, antibodies, and will have smaller chances of contracting major diseases. I breastfeed because it is convenient, portable, easy and because she can have access to it anytime she wants. If I wanted to go out without her I could express enough milk for her to drink. I breastfeed because it eases her discomforts, it nurtures her soul as well as her body, and it offers a warm, safe and peaceful place to be when she is sad or hurts herself.[30]

Introducing Solid Food

Solid foods should ideally be introduced to the infant at 6 months. Prior to that, wholly breastfeeding is not only adequate, but also highly desirable because it provides all the necessary nutrients for growth and development and avoids the possibility of an allergic or hypersensitivity reaction to solid foods, especially where there is a positive family history for atopic disease. The infantile gut is not mature enough to handle food other than mother's milk in the first 4–6 months of life, making the addition of solid foods undesirable until then.

There is also a commonly held belief that if a baby is given solid food late in the day it will aid him or her in sleeping though the night because it will create a feeling of fullness in the baby's stomach. This is, of course, patently untrue because food passes from the stomach into the small intestine in a short period, especially when the food is essentially carbohydrate, as would be the case in a baby. It is also important to note that the potential for choking is much higher in a baby taking solids in the first 6 months of life than after that time.

When confronted with the question from parents as to whether their baby is ready for solid foods, the chiropractor needs first to determine the following:

- Can the baby hold his or her head steady when sitting?
- Does the baby open his or her mouth when food is offered?
- Does the baby show interest in food when other family members are eating?
- Does the baby effortlessly swallow food that is placed on his or her tongue?

Having determined that a baby is ready to start solid foods, the next question will be what foods to offer first. The most easily digested food for a baby starting out on solids is iron-fortified rice cereal. This product is readily available at any supermarket or health food store and is best mixed with mother's milk until it has a consistency much like nectar. Small portions are placed on the middle of the baby's tongue using a teaspoon. It is not uncommon for babies to initially reject a new food, presumably due to the different texture and/or taste. Persistence is sometimes required to get the baby to begin taking the new food. Once the nectar-consistency cereal is being taken comfortably, the cereal should be made thicker, more like a paste. This prepares the baby for the addition of other foods of a similar consistency.

Adding New Foods

Once the baby is comfortable with and is obviously enjoying cereal, other foods should be introduced at a rate of about two each week. The best foods to add next are

vegetables that have been steamed and then pureed as well as the sweeter fruits such as pears and mangoes. Each time a new food is added, the baby should be monitored for any evidence of allergic or hypersensitivity reaction such as diarrhea, vomiting, or the appearance of a new skin rash. It is worth pointing out that fruit juices are not appropriate in the first year of life and are best left out of the child's diet, at least until they can drink competently from a cup. Offering fruit juices in baby bottles creates an unacceptable risk of tooth decay.

By the age of 7–8 months, babies should be having two meals of vegetables and fruit per day (8 tablespoons total) as well as regular breastfeeds on demand. The solid food component can be increased as demand requires, and this may be associated with a reduction in the number of breastfeeds. By the age of 12 months, most babies can eat small portions of the soft table foods the wider family is eating. **Table 13-2** provides a good general guide to offer parents.

The Soy Milk Controversy

Artificial feeding of infants using soy milk formula is promoted to the general public and health care practitioners alike as having significant health-enhancing benefits including in the care of babies with cow milk intolerance (CMI) and cow milk allergy (CMA), both of which are widely, and inappropriately, referred to as lactose intolerance. Research on the use of soy milk baby formula as an alternative in CMI and CMA babies began to appear in the scientific literature in the 1970s; it accelerated exponentially in the 1980s and from there onwards to the present day. There is now a literal plethora of reported research trials on the effects of soy milk artificial formula on CMI and CMA in particular. Results vary widely, but one thing is clear: there is an unacceptably high cross-reactivity between cow milk and soy milk, making the advertising claims suspicious at best. In addition, a review of the epidemiologic literature has not shown any substance to the assertion that soy products confer a degree of protection from certain forms of cancer[31] or that they prevent infantile colic, regurgitation, or prolonged crying.[32]

What does not appear to have been widely disseminated, however, is the possibility of harmful effects of soy products designed for consumption by infants. Soy milk contains extraordinarily high levels of bioactive phyto-estrogens, up to 11 times higher than the levels demonstrated to exert a wide range of hormonal and nonhormonal effects in adults.[33] Although research aimed at determining the digestability and absorption of bioactive phyto-estrogens has concluded that the consumption of soy products in infancy should be regarded as being generally safe, the actual rate of uptake of genesteine and daidzeine, which is much higher than that seen in infants who are breastfed or artificially fed with cow milk formula, has raised concerns amongst researchers. Irvine,[34] for example, raises the issue that because neonates are generally more susceptible than adults to perturbations of the sex steroid milieu, it would be highly desirable to study the effects of soy isoflavones on steroid-dependent developmental processes in

Table 13-2 General Guidelines for the Introduction of Solid Foods in the First Year of Life

Months	May Begin…
At 6 months	Iron-fortified baby rice cereal Strained/pureed vegetables (sweet potato, pumpkin, peas, carrot) Sweet and semi-sweet fruits (mango, pear, banana, avocado)
6–9	Mixtures of pureed vegetables (broccoli, zucchini, etc.) Sweet and semi-sweet fruits (apple, peach, melons, nectarine, apricot) Chunky, soft prepared baby foods (soft carrot sticks and other vegetables) Yogurt, custard Zwieback and other handheld foods Porridge
9–12	Soft, finely chopped foods, soft combination foods such as casseroles, pasta and cheese, rice dishes, firm cheeses, beans, lentils
12 +	Potato Minced meat, poultry, or fish General family foods Fiber foods such as bran, wheat germ, whole wheat cereals, etc. Whole cow's milk

human babies. This reticence to endorse soy outright is also found among other investigators.[35,36]

In addition to the phyto-estrogen issue, soy infant formula is manufactured, at least in part, from soybeans that have been sourced from growers using genetically modified (GM) engineering techniques. In 1999 Baby Milk Action, a U.K.-based group campaigning for safer infant feeding, surveyed the leading U.K. artificial baby milk companies to find out if they claimed their artificial baby milks (both soy-based and modified cow's milk–based) were GM free. This survey was conducted in response to numerous calls from worried parents. At that time Heinz Farleys, Cow & Gate, and Milupa responded that they did not use GM-grown soybeans in their infant formula manufacture. Mead Johnson did not respond to the query, and SMA admitted that it had used GM soy in 1997, but withdrew it due to consumer concern. In the authors' own survey, conducted in Australia, food scientists at all the manufacturers polled were unable to give an assurance that no GM-sourced soybeans were used in the manufacture of infant formula.

There has been much debate among the scientific fraternity now for years over the safety of GM-grown products. Some scientists claim there is no problem whereas others claim it produces new toxins, may damage the immune system, and potentially could cause allergy and some forms of cancer. What is critical to understand in all this is the fact that adults have a widely variant diet whereas the formula-fed child receives only milk, meaning of course that whatever effect there is will be greatly amplified in the infant. The reality is that the effects of GM-grown foods on short- and long-term child development is simply unknown.

Given the present state of knowledge of the effects of soy on development, immune function, and later life; the unacceptable levels of aluminum and other toxic substances; and the apparent uncertainty within the scientific community, the most responsible reaction from the chiropractic profession in terms of public health accountability is to advise patients not to use soy products, at least not in infancy.

Feeding the Older Child

As children progress past the first year of life, they will progressively adopt the dietary habits of their parents and older siblings. Responsible clinical practice on the part of the chiropractor demands that parents are offered sound, general advice on feeding their children. An excellent, time-efficient way to provide such advice can be found in the widely available food pyramid diagram (**Figure 13-6**). A simple explanation of how to use the food pyramid diagram at home when planning and preparing meals can be found in **Table 13-3**.

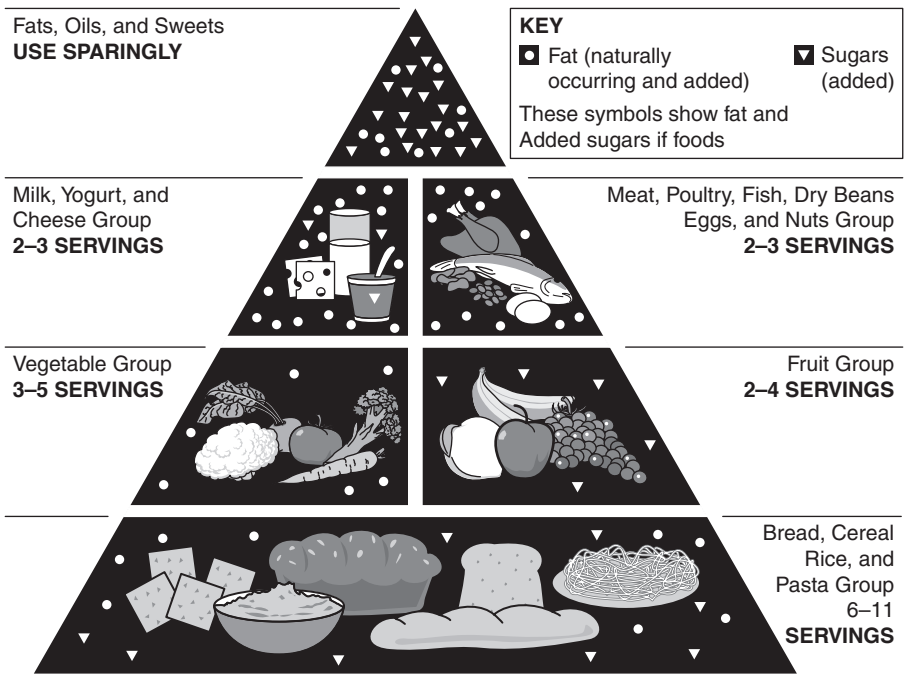

Figure 13-6 Food pyramid diagram.

Table 13-3 Using the Food Pyramid Guidelines

Food Group	Serving Size*	Servings/Day
Grain	1 slice bread 1/2 cup rice (cooked) 1/2 cup pasta	6
Vegetables	1/2 cup raw or cooked 1 cup leafy	3
	1/4 medium melon 1 whole fruit	2
Fruit	3/4 cup juice 1/2 cup canned 1/2 cup berries, grapes	
Milk	1 cup milk, yogurt 2 oz. cheese	2
	2–3 oz. cooked, lean	2
Meat	1/2 cup dried beans‡ 1 egg‡ 2 Tbsp. peanut butter	
Fats/sweets		Limit

*These serving sizes are for 4- to 6-year-old children; serving sizes for 2- to 3-year-old children, except for milk, should be about two thirds of these.

†These amounts are equal to 1 oz. lean meat; two servings are equal to one meat serving.

THE ROLE OF THE CHIROPRACTOR IN CHILD SAFETY SURVEILLANCE

Children can be injured, on occasion very seriously, throughout their early life. Such injury can, and usually is, entirely accidental, while at other times their injuries are intentional.

Intentional Injury

Child abuse, or intentional injury as it is now sometimes called, is a major public health issue and a criminal activity that the chiropractor is uniquely placed to identify and act upon in a social, legal (depending upon jurisdiction), and professionally responsible way. It has been estimated that some 100,000 children each year who have been the subject of abuse or neglect attend chiropractic clinics in the United States.[37] Child abuse in its various forms is not a phenomenon unique to the developed, western world,[39] but indeed is a growing worldwide problem that transcends all classes of people—national, gender, socioeconomic, religious, and cultural. Given the exponential increase in the number of children attending chiropractic clinics over the past 20 years or so, it is not surprising that the chiropractic literature has begun to take seriously the challenge of alerting practitioners to the problem of identifying the abused and at-risk child.[37,39–44]

Although most child abuse happens in the home, increasing numbers of child abuse cases are occurring within organizations such as churches, schools, child care businesses, and boarding schools. Abusive behavior takes a variety of forms and is associated with poverty, family stress, and family isolation. It includes domestic violence, sexual abuse/assault, neglect, and emotional abuse.[45,46] Children suffer from victimization more than any other population group. Victimization has been categorized into three broad groups: the *pandemic*, such as sibling assault, which it is probably reasonable to assume will at some point affect most children[47]; the *acute*, including physical abuse, which affects a smaller but still significant number; and the *extraordinary*, including homicide, which affects only a small number of children.[48] Statistically, throughout 2005 there were 3.3 million referrals of incidents of child abuse to relevant authorities in the United States involving some 6 million children. Tragically, there were 1460 deaths.[49] In all, it has been estimated that 1% of all U.S. children have been the subject of abuse.[50] The statistics are not dissimilar in other developed countries such as Australia where, in 2004, nearly 200,000 reports were made to relevant authorities.[51]

This problem is not getting better with time. To determine the extent of nonfatal infant maltreatment in the United States, the Centers for Disease Control and Prevention (CDC) and the federal Administration for Children and Families (ACF) analyzed data collected in fiscal year 2006 (the most recent data available) from the National Child Abuse and Neglect Data System (NCANDS). The findings in this report indicate that, in the fiscal year 2006, 23.2 children per 1000 population under 1 year of age experienced substantiated nonfatal maltreatment in the United States. Among these infants, neglect was the maltreatment category most commonly cited, experienced by 68.5% of victims. Among infant victims under 1 year of age who experienced substantiated maltreatment, 32.7% were less than 1 week old, and 30.6% were less than 4 days old. Neglect also was the maltreatment category most often cited among children less than 1 week old.[52]

The clinical evidence of child abuse that confronts the chiropractor in private practice varies widely from

being minimal, difficult to quantify, and often ambiguous at the lower end of the severity scale to being very obvious at the higher end. When one considers the current prevalence of child abuse, it is obvious that knowledge of the relevant fundamental principles of diagnosis is essential for every chiropractor. Alertness to the possibility of abuse may save a life or prevent ongoing trauma due to physical, sexual, or psychological trauma and neglect.

Definitions of Abuse

In a broad, general sense, child abuse can be defined as any intentional act, an omission, or a commission that endangers or impairs a child's physical or emotional health and development.[39] In the United States, federal legislation provides a foundation for the states by identifying a minimum set of acts or behaviors that define child abuse and neglect. The federal Child Abuse Prevention and Treatment Act (CAPTA) (42 U.S.C.A. §5106g), as amended by the Keeping Children and Families Safe Act of 2003, defines child abuse and neglect as, at minimum:

> Any recent act or failure to act on the part of a parent or caregiver which results in death, serious physical or emotional harm, sexual abuse or exploitation; or
>
> An act or failure to act which presents an imminent risk of serious harm.

This definition of child abuse and neglect refers specifically to parents and other caregivers. A "child" under this definition generally means a person who is under the age of 18 or who is not an emancipated minor.

Although CAPTA provides definitions for sexual abuse and the special cases related to withholding or failing to provide medically indicated treatment, it does not provide specific definitions for other types of maltreatment such as physical abuse, neglect, or emotional abuse. The U.S. federal legislation sets minimum standards, but each state is responsible for providing its own definition of maltreatment within civil and criminal contexts.[53]

Recognition of Abuse

The child who has suffered abuse may present with either physical or behavioral indicators, nonspecific indicators, or at times a combination of all three, depending on what form the abuse has taken.

Physical Abuse

Physical Indicators

Typically, the child who has suffered physical trauma that is intentional may have bruises at different stages of healing. These bruises frequently have characteristic shapes reflective of the instrument used in inflicting the bruise, such as a stick or electric cord. Fractures, particularly to the face, skull, and spine, are common in such cases and are usually accompanied by an explanation from the parent, caregiver, or child that is incongruent with the nature of the injury. Pattern-shaped burns are also sometimes seen, again the shape being reflective of the instrument used to inflict the wound (e.g., iron, rope, cigarette).[40,54]

Behavioral Indicators

The behavior of the child who has been physically abused sometimes provides vital clues to the diagnosis. The injured child will often say straight out that someone has hurt them, or they (or their caregiver) may offer an explanation for their injury that is incongruent with the nature of the injury. They may display antisocial behavior such as extreme aggression or being withdrawn. They may appear to be afraid of their caregivers or the chiropractor or sometimes display a complete lack of emotion in a situation that would normally be at least a little intimidating to a small child. Finally, expressing a fear to go home or leave the clinic at the end of a consultation is suspicious behavior showing the child is feeling insecure about their safety.[54,40]

Emotional/Psychological Abuse

Physical Indicators

The emotionally abused child seldom exhibits any physical evidence of having been abused, rendering the physical examination of little worth in making the diagnosis. The only exception to this is Ewart's sign, which is sustained retraction and thinning of the upper lip.[55]

Behavioral Indicators

Behaviorally, the emotionally abused child appears to exhibit low self-esteem and often experiences the sudden onset of pathophysiological stress-related conditions such as asthma,[56,57] constipation,[58] and secondary enuresis.[59] A range of other behaviors may also be seen, including depression, anxiety, developmental delay, poor social skills, persistent habit disorders (e.g., rocking back and forth, nail biting), sudden change in

temperament, being withdrawn and tearful, self-harm, sleep disorders, and declining or poor academic achievement.[55,40]

Sexual Abuse

Physical Indicators

Sexual abuse is not often diagnosed by physical signs. The sexually abused child may, however, present with a range of physical indicators, all of which need to be approached in a highly sensitive and respectful, if not oblique, manner. Typically, the sort of physical signs that may be seen are genital irritation or infection, inadequately explained anogenital trauma, persistent vaginal discharge, pregnancy in the very young adolescent, difficulty walking, and recurrent urinary tract infection.[40]

Behavioral Indicators

Behaviorally, the sexually abused child may tell the chiropractor that sexual abuse has occurred. They may complain of headache or abdominal pain, experience difficulty with their schoolwork, display sexual behavior or demonstrate knowledge of sexual practice that is not age appropriate, or experience difficulty in sleeping and relating to adults and peers.[55] Depression and suicidal tendencies also are associated with sexual abuse.[38] Developmental regression, such as the onset of secondary enuresis, may accompany sexual abuse,[60] as may sleep disturbances and "night terrors." Finally, antisocial behavior such as drug addiction and alcoholism may occur,[60] as may sexual promiscuity and prostitution.[61]

Nonspecific Indicators

A range of nonspecific behaviors may result from sexual abuse. These include a sudden change in behavior or temperament, sleep disorders, complaints of headache or abdominal pain, school difficulties, difficulties relating to peers or adults, self-harm behaviors, persistent habit disorders, excessive and inappropriate demands for privacy, and a reluctance to go home from school or other places where the child feels safe.[40]

Neglect

As a category of abuse, neglect is an insidious, chronic problem that may end up proving to be fatal.[40,62] Helfer[63] has described neglect in the following way:

1. *Abandonment/desertion:* The child is left destitute or without adequate support.
2. *Medical neglect:* The lack of adequate medical or dental treatment. There is no direct reference to mental health conditions.
3. *Environmental neglect:* Unhygienic and unsafe living conditions.
4. *Failure to supply adequate clothing:* Lack of enough clothing to protect the child from the elements.
5. *Failure to ensure safety:* The placing of a child in a situation in which there is no or insufficient adult supervision to protect the child from real and significant risk and harm.
6. *Failure to provide adequate food/fluid:* Lack of foods or fluids to sustain normal functioning.
7. *Failure to thrive (inorganic):* Failure to thrive is presented as a likely harmful outcome of neglect, whereas the other subtypes are presented primarily as parental or caregiver omissions. Failure to thrive is directly associated in this type with failure to provide food/fluid partly or entirely as a result of underlying interactive concerns, which contribute to the failure to thrive syndrome.

Physical Indicators

The diagnosis of neglect is arrived at after due consideration has been given to a wide range of physical indicators such as constant hunger, failure to thrive, malnutrition, lack of subcutaneous tissue, poor hygiene, inappropriate dress for the climatic conditions, a lack of adult supervision, unattended medical needs abandonment, and poor dietary habits

Behavioral Indicators

Behavioral indicators of neglect include stealing food, extending days at school, constant fatigue and listlessness, alcohol and drug abuse, claims of there being no adult supervision, aggressive or otherwise inappropriate behavior, isolation from peer group, and chronic school absenteeism. Depression and suicidal tendencies are also associated with sexual abuse.[38,40]

The Role of the Chiropractor in Child Abuse Prevention

Prevention is usually the best possible way for a chiropractor to deal with a problem. The chiropractor, like other health care professionals, has an opportunity to impact the problem of child abuse and neglect by being

proactive in participating in or initiating preventive strategies at both the community and family levels.

At the Community Level

Community-level strategies are preventive, designed to impact families before abusive behavior occurs. These strategies include public education programs, parent education classes, and family support programs. The chiropractor is well-placed to offer classes on such subjects as feeding techniques for babies and toddlers, strategies for settling babies to sleep, and general health and wellness. The idea of these classes is to educate parents, make them aware of the help chiropractic can offer them, and reduce the total stress a child necessarily brings to the home.

At the community level, the chiropractor can also be very helpful in pointing parents and caregivers towards community-based help programs in stress management, family support, and the development of parenting skills. Making patients aware of community-based services and personnel to contact when help is needed is also a valuable public health service that chiropractors can render to families of young children. It is also appropriate for chiropractors to act in an advocacy role on behalf of patients needing to access such services.

At the Family Level

Helping children at this level is more specific in that it entails identifying families under stress who may need assistance from community-based services. In this situation it is appropriate from a public health perspective to intervene on behalf of that particular family and assist them in accessing the necessary services. A very useful strategy at the family level is to visit new parents in their homes soon after they return from the hospital with their new baby to make sure they are coping with the stress of having a newborn in their home.

When Abuse Has Occurred

In the event the chiropractor has taken a case history, performed a physical examination, and on balance believes the physical, behavioral and nonspecific evidence suggest that abuse of the child has taken place, the law requires that a report be initiated. All 50 states in the United States have mandatory reporting, making it a breach of the law to not report suspected cases of abuse. It is critical that all chiropractors make themselves aware of the contact details of the appropriate authority relative to the jurisdiction in which they practice and have it on record in case it becomes necessary to make a report of suspected abusive behavior. It should also be remembered that the chiropractor is not responsible for the diagnosis of abuse, but only that the physical, behavioral, and nonspecific evidence is suggestive of abuse. In most jurisdictions a report can be initiated in three ways. The first is to a local child protection unit, which is usually staffed by social workers with specialty training in abusive family situations. This is the appropriate referral if the child you are concerned about is not, in your opinion, in immediate physical danger or in need of urgent medical care. The second option is to report to a hospital's emergency department if the child is in need of immediate medical care. Thirdly, and finally, there is the police. The police should be called in only in cases where, in your opinion, the child is in immediate physical danger or will be if allowed to go home.

The role of the chiropractor does not stop after a report has been initiated. Ongoing care and emotional support for the family during the likely stressful sequelae to a report of abuse is crucial to their recovery as a family unit, as is helping them access whatever family, social, or psychological services that may be needed.

THE ROLE OF THE CHIROPRACTOR IN ENVIRONMENTAL SURVEILLANCE

A safe environment for children to grow up in extends beyond just being safe from intentional injury and neglect. There are many products available today aimed at the child market, and not all of them are in the best interests of the safety of the child or in their developmental well-being. Although a summary of every available product on the market that falls into this category is outside the scope of this chapter, a description of two will suffice to demonstrate the responsibility a chiropractor has in a public health sense to educate and warn the consuming public. The chiropractic biomechanical understanding of body structure and function and its effect on development places the chiropractor in a unique position to assess such products on an individual basis from the perspective of their potential biological impact.

Trampolines

The recreational use of trampolines has increased dramatically during the last 10 years. During that same

time, there has been a striking parallel increase in the number of children presenting to fracture clinics with injuries associated with trampoline use.[64–66] To a large extent, the serious injuries that happen to children while trampolining occur when they have no adult supervision. In one study conducted in Ireland, of the children presenting to a public hospital orthopedic clinic over a 6-month period with injuries sustained while trampolining, 60% were unsupervised by an adult at the time.[67] A study conducted in the United States demonstrated that there is no significant difference between the rate or type of injuries occurring with the so-called mini-trampolines as opposed to full-sized trampolines.[68]

Injuries related to trampolining are typically orthopedic in nature, involving the cervical spine and upper limbs. However, more serious neurologic injuries do occur, such as quadriplegia,[69,70] and conditions involving the vasculature also are on the rise. Although strokes, thrombi, and embolus formation in children related to sports injuries are rare, the incidence associated with trampoline use is increasing. Minor trauma to the vulnerable extracranial vertebral arteries as they travel superficially through the dorsum of the neck can begin a cascade of events that may result in arterial dissection, thrombus formation, and embolization with cerebral infarction.[71] Other vascular complications of trampoline injuries have also been recorded in the scientific literature and should be noted by chiropractors caring for children with such injuries.[72]

Some physicians and physiotherapists charged with caring for children with cystic fibrosis (CF) claim that cardiopulmonary performance, sputum production, and general well-being are all enhanced by the judicious and supervised use of trampolining. However, a study conducted at the National Center for Cystic Fibrosis, Edmond and Lily Safra Children's Hospital, Chaim Sheba Medical Center in Tel-Hashomer, Israel, in which the authors conducted an exhaustive search of the scientific literature on trampolining as a therapeutic modality for cystic fibrosis patients, concluded that the presumed benefits of trampoline use for CF patients are not proven and furthermore, the suggested benefits could be acquired using other types of exercise. The authors further concluded that, weighing the known risks of trampolines against the potential benefits that are not unique to this particular exercise modality suggests that the use of trampolines for CF should not be recommended.[73]

The rate of increase in trampoline-related injury to children is becoming a serious public health issue[74] and has resulted in various calls in the scientific literature ranging from those who favor a complete ban[75,71] on sales of trampolines to those who recommend that strict guidelines for the recreational use of trampolines be put in place; the latter further recommend that no child should be on a trampoline either with another child or unsupervised by an adult.[65,67,68,76]

In 1999 the American Academy of Pediatrics (AAP) recommended that trampolines should never be used in the home environment, in routine physical education classes, or in outdoor playgrounds.[77] In 2006 this policy was reaffirmed based on the evolving data of recorded injuries from trampolining accidents, 30% of which were fractures, many resulting in hospitalization and surgery.[78]

Given the increasing frequency of serious injury to children using trampolines in a home environment and the less severe injuries, some of which are being seen by chiropractors that are not being reported in the scientific literature, it seems that on balance the most appropriate advice for chiropractors to offer parents is to avoid buying a trampoline for home use. This advice would be in keeping with the official policy of the AAP and would be the most resonant with the opinions expressed in the scientific literature. Chiropractors can also play an important public health role by educating parents about the dangers of trampolines, thereby empowering them to make informed choices about the toys they buy their children.

Baby Walkers

A baby walker is a device that allows a baby who has yet to develop the ability to walk unaided to be held in the upright position while bearing some weight through the legs. The child is then able to "walk" around in the device. Some basic neurodevelopmental physiology should be considered here. Probably the most important thing to consider is the effect on motor development of placing a child in the walking posture when their neurodevelopment is at the crawling stage. Although there may be some convenience benefits to the parents/caregivers, the baby's gross motor development is far better served by placing them prone and allowing them to roll and crawl around the floor.[79–81] The relationship between the prone position and subsequent neurodevelopment has long been well understood, and now that prone sleeping has been causally linked to sudden infant death syndrome (SIDS),[82] placing baby in the prone position during waking hours has become far more critical.

Aside from the negative effect of walkers on neurodevelopment there is the important issue of potential injury, particularly from falling down stairs. The AAP has estimated that during 1999, 8800 children under 15 months of age were treated in emergency departments across the United States for baby walker–related injuries.[83] In an attempt to lessen the rate of such injuries, manufacturers have developed a braking mechanism, designed to stop the walker if one or more wheels drop off the riding surface. These braking systems, however, have been demonstrated to be ineffective and may offer parents a false sense of security.[84]

The AAP policy position on baby walkers is clear cut in that it recommends that baby walkers be banned from sale. Along with the pediatrician and family general practitioner, the chiropractor is in a powerful position to influence parents to avoid purchasing baby walkers, and should take every opportunity to do so both during consultations and in a broader sense by providing information to the wider public about the dangers of walkers and advising the use of stationary activity centers instead. However, despite the best advice, there will be parents who are insistent about buying a baby walker; these parents should be advised to make certain the one they buy meets the revised voluntary performance standards (ASTM F977-96).[85]

Sleep Posture and Sudden Infant Death Syndrome

In 1992 the AAP, following analysis of the growing evidence suggesting that the prone sleeping posture in babies was a major factor contributing to the incidence of SIDS, adopted a policy position recommending all babies sleep in any nonprone position (i.e., sidelying or supine) with the exception of those at risk of aspiration of vomitus from gastro-esophageal reflux and other conditions. In 2000, on the basis of new evidence, the AAP advised that the supine position was the preferred position because it offered the greatest level of protection from SIDS, although side-posture sleeping, though not as good as supine sleeping, was still better than prone sleeping.[86]

In addition to the sleep posture, other factors that have been shown to be causative in SIDS are exposure to an environment where the parents smoke and bed cosharing when the mother is a smoker.[83,86,87] On the positive side, there is compelling evidence that pacifiers offered at sleep time reduce the risk of SIDS, even though the actual mechanism is not understood.[88-94] Breastfeeding also has been shown to be protective in some studies.[95-98] Although somewhat controversial, the research of Dr. Jim Sprott[99] in New Zealand is demanding of attention. Sprott has shown that when mattresses are wrapped in a specially prepared polyethelene cover, they are prevented from giving off certain poisonous gases, which he claims cause SIDS.

Chiropractors can make a significant contribution to the effort to reduce SIDS both by advising parents during consultation and by supporting health promotion initiatives to the broader community in relation to the following strategies, which are largely consistent with those recommended by the AAP:[100]

- Place infants to sleep on their back unless there is the danger of aspiration of vomitus.
- Use a firm sleep surface and keep soft materials and objects out of the crib.
- Do not smoke during pregnancy or inside the house after the birth of the child.
- Keep the child in the maternal bedroom but separate from the parental bed, especially when the mother is a smoker.
- Offer the baby a pacifier at nap time.
- Avoid overheating the child with blankets and the like.
- Avoid commercial home monitor devices that are marketed on the premise they reduce the risk of SIDS. They simply do not work.
- Always fully envelope wrap mattresses in a specially prepared polyethelene cover, which is available commercially.

CONCLUSION

In terms of discharging public responsibility for health promotion and disease prevention, all that is really required is a little personal availability of the chiropractor to participate in public health education initiatives and the investment of time and resources in providing written information to parents to empower them to make better choices for their children. Investing in the future health and well-being of the children who will one day constitute the adult population in the communities in which we live is a professionally responsible choice.

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CHAPTER
14

Aging, Public Health, and Chiropractic

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CHAPTER OUTLINE

Never before in the history of humankind has the fastest growing subset of the population been those over 85 years of age.[1] The first signs of the "silver tsunami" have begun to lap at the shores of most nations, and the United States is no exception. According to a recent press release by the U.S. Census Bureau, the nation will be more racially and ethnically diverse, as well as much older, by midcentury. Minorities, now roughly one third of the U.S. population, are expected to become the majority in 2042, with the nation projected to be 54% minority in 2050. By the year 2030, when all of the baby boomers will be 65 or older, nearly one in five U.S. residents is expected to be 65 or older. This age group is projected to increase to 88.5 million in 2050, more than doubling the number in 2008 (38.7 million). Similarly, the 85 or older population is expected to more than triple, from 5.4 million to 19 million between 2008 and 2050.[1] Even conservative estimates project that there could nearly 1 million U.S. residents over the age of 100 by 2050.[2] Globally, the age wave is even more significant than in the United States, with most industrialized nations having a life expectancy greater than that of the United States. For example, in Japan and much of Europe more than 20% of the population is already

over age 60.[3] This new phenomenon of a graying world means that we are setting out on the uncharted waters of the silver tsunami together.

The health care challenges in an aging population will be most profound if we continue with "business as usual"—waiting for chronic diseases to disable our patients (and our health care system), and then trying to fix patients after years of poor choices have taken their toll. Pouring money and resources into the endgame is a most inefficient and ill-advised strategy for an aging society. Doctors of chiropractic (DCs) and public health professionals have historically valued a more proactive approach to promote health and wellness and prevent disease from occurring. Additionally, both professions value early intervention before the more expensive interventions like surgery or emergency care are needed. Although these values are noble indeed, they cannot positively impact an aging world unless implemented in day-to-day practice. Examples of this value set can be seen in the chiropractic health services literature, in which the vast majority of chiropractors recommend actively engaging in promoting healthy behaviors (like exercise or proper nutrition) in their practices along with chiropractic adjustments.[4–6] This example of chiropractic's role in addressing the health needs of our aging population will be explored further in this chapter, and has also been described in previous publications.[7,8]

This chapter contains three sections. In the first section, we examine how chiropractors can engage in public health efforts at the national, state, and local levels in ways that can positively impact our aging population. In the second section, we explore some specific public health concerns common in aging adults and present ways in which chiropractors can play a health care role in each. This section also includes case-based scenarios from chiropractic practice. The final section briefly discusses the range of living options older adults may consider as they age. Surely, in an aging society this list is bound to grow and change, but a beginning is included here for consideration. A conclusion with resources for aging individuals and their health care providers wraps up the chapter.

CHIROPRACTIC AND THE PUBLIC HEALTH EFFORT

Doctors of Chiropractic can get engaged in the public health effort through involvement at many different levels. Some may wish to simply participate in patient care to help improve our nation's health, one patient at the time. Others may decide to find a county or state level health organization to join, or even to lead. A few hundred chiropractors have taken their public health involvement to the national level, through involvement in the nation's oldest and largest health organization, the American Public Health Association. In the paragraphs that follows, we will explore public health involvement at various levels and suggest ways for chiropractors to engage.

National-Level Involvement: The American Public Health Association (APHA)

One example of chiropractic's participation in public health efforts at the national effort is the American Public Health Association's Chiropractic Health Care Section (APHA-CHC). The APHA has put chiropractic at the center of the public health effort. Established in 1994, the APHA-CHC has been a forum for chiropractors to engage in the public health effort at the national level and on a level playing field with other health professionals.[9] In terms of aging, the APHA has many opportunities for chiropractic involvement. One example is to join the Gerontological Health Section (in addition to the Chiropractic Health Care Section, of course). The Gerontological Health Section focuses its efforts on aging and age-related education, health policy, health promotion, and disease prevention.

Aging is also the focus of another APHA group. In 2005, a dozen APHA members formed the Task Force on Aging, and in 2008, this group was reconfirmed by the APHA Executive Board as the "APHA Forum on Aging." This forum is open to all APHA members and affiliates, and now includes more than five dozen experts in the field of aging from numerous sections, states, and backgrounds.[10] A chiropractor has served in an elected leadership position in the Forum on Aging since 2007. APHA members can read more about the APHA Forum on Aging, its members, and other related action groups at http://www.apha.org.

This is one example of how a chiropractor can stay tuned in to the needs of the aging population through national-level engagement and communication with public health leaders in the field of aging. This chapter's authors have both served in leadership roles within the APHA-CHC and recommend that readers join the organization so that your chiropractic voice will become part of the national-level public health effort.

Chiropractic in State-Level Public Health Efforts

Although the current level of chiropractic involvement in state public health efforts related to aging is somewhat

limited, there is at least one notable chiropractor who works in a state governmental position: Dr. Robert Mootz of the Washington State Department of Labor and Industries. He is the first chiropractor ever employed full time in a state government health official role. His high ethical standards and commitment to ensuring that the evidence base will be used to inform and improve health policy and practice are commendable contributions to the state-level public health workforce. There is no doubt that a chiropractor's involvement in this state governmental position has been a positive for both chiropractic and Washington's aging workforce. A noteworthy document coauthored by this state government–employed chiropractor is *Chiropractic in the United States: Training, Practice, and Research*.[11] It outlines chiropractic utilization, training, research, and other relevant topics in the profession.

Chiropractic, Public Health, and Aging: The Community Level

Although involvement at the national and state level may be of interest to only a few, virtually *all* chiropractors can play a role in aging-related public health efforts in their local communities. If we remember that one definition of public health refers to efforts made to promote, protect or restore health, we can easily see that this is what chiropractors do every day in practice. Simply removing human suffering by providing chiropractic care to aging patients is a great contribution to the public health effort. However, a deeper involvement in community-level public health efforts can be sought by developing relationships with aging-focused public health workers in your community. A first step towards this type of involvement is to identify age-related health organizations, businesses, and programs in your community. Examples of such organizations include county health departments, Area Agencies on Aging, and centers for aging services. Meeting with the directors of such organizations is a positive first step. Once a connection has been made, the chiropractor can simply ask what they can do to help. This is how community-level engagement is born.

Chiropractors communicating with their local health department directors should inquire about any ongoing public health efforts in their community related to aging. It is likely that the local health department has a printed report outlining the health needs of its community and the health department's focus areas. Chiropractors can request and review such reports to learn more about the health issues predominant in their community, and what effort may be of interest to them. Often health departments also have an action plan that includes action steps on how the department plans to address the needs and health issues identified in its community. Although the foci of such reports vary widely, many forward-thinking public health departments have committed to addressing issues related to the aging of their community. Offering to participate in meeting the community's health goals can result in a long and fruitful relationship wherein chiropractor, health department, and the aging community all benefit.

Geriatric Education Centers (GECs)

Most states have one or more federally funded geriatric education centers within their boundaries. These centers are funded by the U.S. Health Resources and Services Administration, and focus on the education of professionals, including chiropractors, on the topic of geriatrics. Chiropractors should visit the National Association of Geriatric Education Centers (NAGEC) website to find a GEC near them (http://www.nagec.org/Content/membership.asp). Visitors can also review the current activities of their local GEC and find out if there are ways to get involved in the educational programs or clinical experiences offered through their local GEC.

There are several examples of chiropractic involvement in GECs. In fact, both authors of this chapter have affiliations with their local GEC. Palmer College of Chiropractic has been a funded collaborative site of the Iowa GEC (IGEC) for nearly a decade, since its inception. Through government-funded projects and in her role in the IGEC, Killinger developed, pilot-tested, and continues to teach and assess a Model Curriculum in Chiropractic Geriatric Education. More recently, the IGEC has provided an opportunity for Palmer College students to do observational rounds through the Veterans Administration (VA) Hospital's Geriatric Assessment Clinic. This gives students, trained in a very uni-professional environment, the opportunity to observe in-depth geriatric assessment alongside nursing, pharmacy, physical therapy, social work, and medical professionals. Students also participate in interdisciplinary team meetings at the VA to chart a course of care for the patients seen in the VA Geriatric Assessment Clinic.

In New York, the Finger Lakes GEC has also included chiropractic within its GEC grant, through the leadership of chapter author Paul Dougherty. At this location, students from New York College of Chiropractic participate in rotations in which they provide chiropractic care within a long-term care center and the VA, alongside a varied team of health professionals. The GEC grant in

New York is also funding the development of a new curriculum and training modules on the topic of geriatrics for chiropractors.

In Missouri, the St. Louis Gateway GEC, under the leadership of Dr. John Morley, has included chiropractic professionals from Logan College of Chiropractic in its granted activities since the mid-1990s. Dr. Norman Kettner of Logan College of Chiropractic and others have participated in collaborative geriatric educational forums and have put on forums for interdisciplinary audiences through the GEC in that state. GECs offer an excellent resource and opportunity for chiropractors to participate in a wide variety of programs focused on geriatric care and education.

Advocating for Health and Safety in Older Patients

Public health happens. For most chiropractors, it happens one patient at a time. The work that we do in chiropractic practice with each patient certainly makes a significant contribution to the overall public health effort. The importance of this one-on-one public health work is not to be downplayed. Aging patients who, through the care, recommendations, and vigilance of their chiropractor, experience better health are profoundly and positively impacted.

Public health practices are not "one size fits all." Although some recommendations for healthy aging are relatively universal (e.g., smoking cessation and getting some regular physical activity), many recommendations for healthy aging must be made only after careful consideration of the patient's specific health needs.

SPECIFIC PUBLIC HEALTH CONCERNS IN THE AGING

In this section, we will examine the role of chiropractors in addressing some common age-related public health concerns. While there are literally dozens of health issues that could be included in this section, we will remain focused on a few of the leading health issues, responsible for a large portion of morbidity in the aging population. We have also selected topics that have previously been identified as leading health concerns according to the Healthy People 2010 document.

Musculoskeletal Disorders and the Aging Patient

Bone and joint disorders account for more than half of all chronic conditions in people older than 50 years of age in developed countries, and are the most common cause of severe, long-term pain and disability. Ironically, musculoskeletal (MSK) diseases are not among the top 10 health care conditions funded by research dollars.[12–13] One of the reasons for this is that there is little mortality directly associated with MSK disease, although there is a tremendous amount of morbidity associated with them. Musculoskeletal pathology also places a tremendous burden on the health care system. For the years 2002–2004, the annual average direct cost for musculoskeletal health care was estimated at $510 billion, the equivalent of 4.6% of the gross domestic product.[14] According to the Medical Expenditures Panel Survey (MEPS), 23% of MSK diseases occur in adults over the age of 65. Musculoskeletal pain is not only an issue in community-dwelling older adults, but also in residents of long-term care (LTC) facilities. Recent work has found that 40% of residents in an LTC facility reported musculoskeletal pain.[15]

It is imperative that the doctor of chiropractic be aware of the impact of MSK diseases on older adults, and that aging patients learn of the role chiropractic may play as a conservative care option. In this section, we will include cases of chiropractic patients to help illustrate the potential role of chiropractic in addressing these significant public health concerns.

Osteoarthritis

Osteoarthritis (OA) is by far the most common joint disorder in the United States and throughout the world. It is one of the leading causes of disability and pain in older adults.[14] OA can occur in any joint, but is most common in the hip, knee, and the joints of the hand, foot, and spine. The course of the disease varies but is often progressive. In this section, we will explore the role of chiropractic in management of OA, as has been discussed in previous chiropractic and general science literature.[16,17]

Incidence, Prevalence, and Risk Factors

Few reliable data are available on the incidence of OA due to inconsistencies in the definition and diagnosis of this disorder. However, some basic information is relatively clear: The incidence of osteoarthritis is higher among women than among men in all age groups, and in both men and women the highest incidences occur in people over the age of 75. Population-based studies also indicate that overweight people are at greater risk of developing OA of the knee than persons of average weight.[18] Worldwide estimates are that approximately

10% of men and 18% of women over 60 years of age have symptomatic osteoarthritis.[18]

From a public health standpoint it is important to be aware of the modifiable risk factors for OA, such as obesity, occupational factors, muscle weakness, and nutritional factors. Trauma and certain physically demanding activities or occupations are also risk factors for the development of osteoarthritis of the knee and hip. Farming presents the greatest occupational risk for osteoarthritis.[18]

A Chiropractic Case to Consider: Ernestine Struggles

Ernestine really is struggling. She is only 65 years old and once was quite an active, able woman. She raised four children on her family's farm, but over the past few years she has become so disabled with what she describes as "arthritis pain" in her knees and back that she now spends most of her time sitting in her chair and watching TV. She is 5'6'' and weighs 180 pounds. Although she can still drive, she is afraid she might have to give that up someday soon. Ernestine confided in a friend about her pain and her friend suggested that chiropractic might help her, but she is very afraid of having her back "cracked." Ernestine used to perform all activities of daily living without assistance, but now due to pain, she needs help doing laundry and basic housework. She takes over-the-counter anti-inflammatory and analgesic medications for her pain, but has not seen a doctor.

Ernestine reluctantly goes to see her friend's chiropractor, who does a comprehensive assessment of the knee and spine to rule out active or new joint pathology or infection. After a thorough orthopedic/neurological and x-ray examination of her knees and low back, it is clear that osteoarthritis is a significant contributor to her pain. The chiropractic examination also indicates some areas of spine and extremity misalignment and restricted motion in the lower back, hips, and knees.

Osteoarthritis Care Options and the Evidence

The goals of treatment for OA should include relieving symptoms, maintaining or improving function and range of motion, and limiting physical disability. There are a variety of different treatment options for OA that have some evidence of success, according to the scientific literature on OA. These treatments include patient education, exercise therapies, weight loss, and manual care.[17,19] Because all chiropractors do manual care, and over 90% of practicing chiropractors report that they provide patient education and talk to patients about exercise and diet, the role for chiropractors in caring for OA is clear.[4]

Patient education materials including pamphlets and online resources from the Arthritis Foundation are available through local Arthritis Foundation chapters. Many different exercise programs have been purported to be effective for reducing pain and disability associated with OA. Tai chi has been utilized in several studies in older adults with OA and has been shown to reduce pain.[20] Manual therapy is broadly defined as a "hands on" approach to treatment. Manual therapy may include soft tissue techniques, joint mobilization, and high velocity, low amplitude manipulation or chiropractic adjustment of the joints. There are little data concerning the treatment of OA with manual therapies; however, according to the National Board of Chiropractic Examiners (NBCE) survey, 60% of chiropractors state that they are the sole treatment for their patient's OA symptoms.[4] There is certainly an opportunity for further investigation on the efficacy of chiropractic care for osteoarthritis.

Ernestine and Chiropractic

The chiropractor, respectful of Ernestine's apprehension about traditional chiropractic care ("cracking"), provides chiropractic care using flexion-distraction technique to restore motion and reduce stiffness in her low back. This technique, one of the top 10 most commonly used chiropractic care strategies, is described in the context of geriatric care by Killinger.[21] Ernestine also receives some soft tissue and range of motion work and gentle instrument-assisted chiropractic adjustments to the knees, described in the same article.[21] Ernestine tolerates this type of care well, and reports some improvement after each of her first three visits, and significant improvement within 2 weeks of initiating care.

Other Factors in Ernestine's Care

Ernestine's weight and sedentary lifestyle are certainly contributing to her pain, reduced mobility, and functional limitations. The current scientific evidence supports physical activity to maintain and increase flexibility and strength around the afflicted arthritic joints, so the chiropractor provides her with some educational materials from the Arthritis Foundation and also helps her select appropriate physical activities to do at home from the book *Exercise and Physical Activity: Your Everyday Guide from the National Institute on Aging*.[22] The chiropractor advises her which exercises

would be most helpful and has her demonstrate that she can appropriately complete the physical activities suggested for her. She sets a goal and follow-up dates with her at 1 and 3 weeks to monitor her progress. Ernestine is encouraged to continue doing her physical activities at home, so the chiropractor helps her obtain her own free copy of the exercise book. Within 3 months, Ernestine has joined a local "mall walkers" group and reports improved mobility, function, and overall mood since beginning care.

Back Pain

Low back pain is a major public health concern in most industrialized countries, with nonspecific back pain considered to be the most common type.[23] Many cases of low back pain have a recurrent course, with further acute episodes within 1 year in the working population and lifetime recurrences of up to 85%.[23,24] Chronic back conditions are listed among the leading health indicators in the Healthy People 2010 document.[8]

Incidence, Prevalence, and Risk Factors

Back pain is very common, but its prevalence varies according to the definitions used and the population studied. Back pain is not selective, but is a major concern for all ages and ethnic backgrounds. The reported point prevalence ranges from 12% to 33%, 1-year prevalence ranges from 22% to 65%, and lifetime prevalence ranges from 11% to 84%.[25] Back disorders are found more frequently among persons age 75 or over than in any other age group. Back disorders accounted for 81% of health care visits in this age group in 2004.[25] Back pain is one of the top three most common complaints of older adults presenting to their physician. Recent data suggest that the costs for lower back pain in older adults continue to rise, and yet there is little improvement in the outcomes or incidence of lower back pain.[26]

The occurrence of low back pain is associated with several factors that are similar to those associated with osteoarthritis. These include age, physical fitness, smoking, excess body weight, and lack of core muscle strength.[26] Psychological factors associated with occurrence of back pain are anxiety, depression, emotional instability, and pain behavior (e.g., fear avoidance belief behavior).[27] Occupational factors, such as heavy work, lifting, bending, twisting, pulling, and pushing, clearly play a role, as do psychological workplace variables, such as job dissatisfaction. Psychosocial aspects of health and work in combination with economic aspects seem to have more impact on work loss than physical aspects of disability and physical requirements of the job.[28] Economic factors and an increasing life expectancy make such occupational health issues increasingly relevant in the aging population.

Burden and Impact of Back Pain in Older Adults

Back pain has a marked effect on the patient and on society because of its frequency and economic consequences. Chronic pain is a common symptom reported by an estimated 50% of community-dwelling older adults, and it has the potential to threaten their functional independence and ultimately lead to rising health care costs. Recently, researchers found that the prevalence of pain in various body regions declines with age; however, the degree of pain interference with daily life increases with age.[28] Back pain not only is a problem for older adults living in the community, but also affects older adults living in nursing homes. The prevalence of pain in nursing home populations is higher than that of community-dwelling older adults. A recent review of six studies of long-term care settings found back pain rates ranging from 49% to 83%, with 25–50% of community-dwelling adults experiencing pain.[29] Unrelieved pain increases the risk of cognitive failure, loss of physical function, increased depression, greater mood disturbance, diminished sleep patterns, less deep slow-wave sleep, and lower pain thresholds.[30,31] Recently published manuscripts have described the role of chiropractic care in addressing MSK pain in community-dwelling elders.[32,33]

A Role for Chiropractic: Care of Older Patients with Back Pain

The role of the chiropractor in the care of older adults with back pain is a fairly new discussion in the scientific literature, in spite of a 100+ year history of clinical chiropractic care in this age group. Although care strategies may vary among chiropractors, the core intervention is the chiropractic adjustment. Other common interventions commonly employed by chiropractors in the clinical setting include soft tissue techniques, active care (or rehabilitative exercise), ice, heat, and other modalities.[4] A small number of randomized controlled clinical trials are underway to evaluate the efficacy of various types of chiropractic care in older adults with low back pain.[34] One published study compared spinal manipulation (high velocity, low amplitude) to a nonmanipulative mind–body approach in older adults with chronic

musculoskeletal pain and found no significant differences in outcomes.[35] Hawk and colleagues also published a practice-based study in older adults and reported on improved outcome measures in older adults undergoing chiropractic care.[5] These studies give some credence to the use of manual methods and mind–body techniques to treat back pain in this population. There are questions about the safety of chiropractic care in this population; however, there is a growing body of literature documenting the safety of spinal manipulation even in the frail elderly population.[36,37]

There is also some evidence for other treatment methods for chronic back pain in older adults, including different exercise modalities such as tai chi and water exercises.[20,21] It should be noted that there have been relatively few randomized controlled trials evaluating the role of exercise or other pain control modalities such as electric stimulation[36]; however, one study did evaluate the role of electrical stimulation plus exercise for back pain in older adults and found that the electric stimulation did not seem to significantly enhance the effectiveness of the exercise, although both groups did show significant improvement.[36]

When initiating care of pain in older adults, care should be taken to evaluate all comorbidities and whether these may represent a contraindication for some types of therapies. One specific example is the risk of significant bruising associated with the use of aggressive soft tissue techniques in patients who are currently undergoing anticoagulation therapy. Currently millions of patients annually receive anticoagulation with a vitamin K antagonist, specifically warfarin, for the prevention of venous thromboembolism and systemic embolism associated with atrial fibrillation and prosthetic heart valves. Atrial fibrillation affects nearly 2.5 million people in the United States, and a significant percentage of these patients are on anticoagulants.[37] Recently some data are reporting that high velocity, low amplitude spinal manipulative therapy (SMT) may be safe in these patients, but caution should be exercised.[38]

Osteoporosis

Osteoporosis has been called the "silent thief" because it typically progresses without symptoms until a fracture occurs. Osteoporosis is characterized by low bone mass and deterioration of bone structure that causes bone fragility and increases the risk of fracture. In 2002, an estimated 44 million persons over the age of 50 in the United States were at risk for fracture due to osteoporosis or low bone mass. If the current trend continues, and new treatments are not found, it is estimated that by 2020 over 61 million persons will be at risk.[39] The economic burden of inpatient, outpatient, and long-term care of osteoporotic fractures was estimated at $17 billion in 2005; cumulative costs over the next two decades are estimated at $474 billion. This number does not include the costs associated with morbidity and disability associated with this disease.[40]

A Chiropractic Case to Consider: Ruth's Bad Break

Ruth is a 78-year-old female of German descent. She is very active and energetic, and is involved in many activities in her community such as volunteering at a hospital and also at a local food pantry. Ruth is 5'8'' and 160 pounds, and eats a wide variety of meats, fruits, vegetables, and whole grains. She does not like milk, so hasn't consumed any since she was a toddler, but confesses to liking ice cream a bit too much! She is taking no medications and has had no hospitalizations over that past two decades. She comes to the chiropractic office due to a "sharp pain in the middle of her back," which she wants checked before her trip to Malta in a few days. When questioned, she states that the pain began subsequent to moving some lawn chairs so she could mow the grass under them with her push mower. She rates the pain as an 8 on a scale of 1 to 10, and reports that the pain made it very hard for her to sleep in any position. She usually performs all activities of daily living with no pain or need of assistance, but since this pain started yesterday, she has not been able to do much around the house.

Ruth's physical examination reveals pain, muscle guarding, and slight swelling over the mid-thoracic spine. All other assessments are within normal limits. Her history reveals several risk factors for osteoporosis as listed in the checklist below[17]:

Common Nonmodifiable Risk Factors for Osteoporosis:

- Female
- Older age
- Small frame (thin or low birth weight)
- Fair skinned, European or Asian descent
- Family history of osteoporosis
- Complete hysterectomy before menopausal age

Modifiable Risks for Osteoporosis:

- Sedentary lifestyle
- Frequent consumption of coffee, caffeinated beverages, or soda pop (>2/day)

- Alcohol consumption (>2/day)
- Tobacco use or exposure
- Avoidance of/aversion to dairy products

After taking anterior-to-posterior and lateral x-rays of the area of chief complaint it was confirmed that Ruth has recent compression fractures of the eighth and ninth thoracic vertebrae, and signs of significant bone density loss in the spine. Ruth's case offers an example of the insidious nature of osteoporosis and the impact it can have on an apparently healthy, active patient.

The Chiropractor's Role in Ruth's Care

Nobody had ever screened Ruth for osteoporosis risk factors or discussed the steps she can take to build bone density. There is an opportunity for the chiropractor to take an active role in the assessment of her baseline bone density and provide recommendations for a bone-building lifestyle to prevent further disability due to osteoporosis.

The Screening Gold Standard for Osteoporosis

The World Health Organization (WHO) recommends that the diagnosis of osteoporosis be based on the results of dual-energy x-ray absorptiometry (DXA). This test defines osteoporosis as bone mineral density (BMD) of greater than 2.5 standard deviations below the average value for a young, healthy woman (e.g., T-score of <–2.5 SD). Osteopenia or low bone mass is defined as –1.0 to –2.4 SD, or 10–30% below normal bone mass.[41]

The current literature recommends that persons over the age of 65, particularly those at risk for osteoporosis, take calcium and vitamin D supplements: 1000–1500 mg/day and 400–800 IU, respectively[41,42]; however, the latest meta-analysis on vitamin D indicates that a dose of 800 IU of vitamin D daily is significantly more effective at preventing osteoporosis-related fractures.[43] Patients with osteoporosis should also try to get 30 minutes a day of bone-building physical activities (axial loading–type exercise) such as stair climbing, walking, or weight lifting.[41,42]

Ruth Gets Busy Building Bone

Once Ruth returns from Malta, the chiropractor recommends that Ruth join a local exercise class, with the permission and supervision of her primary health care provider. She also purchases a high-quality acid-based calcium/vitamin D supplement. The chiropractor recommends that she take no more than 500 mg of calcium at a time and to take it along with an acidic food or juice such as orange juice, to further enhance absorption. She also recommends that Ruth spend some time in the sun when she can in order to get more vitamin D.

On Ruth's next visit to her physician, she may be advised to consider taking bisphosphonates or other drug therapies to increase bone density. The chiropractor may choose to share resources and background information about such options to help her make informed choices related to drug interventions. Any well-rounded approach to the prevention and treatment of osteoporosis should not only include, but also focus on the two strategies listed above: physical activity and supplementation with calcium and vitamin D.

Falls

Falls and fall induced injuries of older adults are a major public health concern in our aging society. Approximately 1in 3 older adults living in the community and more than half of those living in long-term care facilities fall every year.[44] Falls also represent one of the most common injuries in chiropractic offices, usually involving older patients. Approximately 4–5% of all falls result in a fracture and an additional 5–11% cause other serious injuries. Falls that cause a fracture are associated with a high level of morbidity and mortality. To illustrate this point, of the elderly who experience a hip fracture, about half never return home or live independently again.[45] Chiropractors should be well-aware of how to identify patients at risk for falls and fall prevention strategies.

Incidence, Prevalence, and Costs: Falls in Older Adults

According to the Centers for Disease Control and Prevention (CDC), in 2005 a total of 15,802 persons age 65 or older died as a result of falls. Hip fractures are associated with a 36.6% mortality rate at 2 years postfracture.[46] In addition to hip fractures, vertebral fractures associated with falls are also on the rise. Recent studies have reported that those over 65 years of age who fall and sustain a cervical spine fracture and spinal cord injury have a 21–30% mortality rate.[46] Aside from the death and disability related to falls, there is also a significant cost related to falls: The annual cost in the United States associated with falls is estimated at $20 billion per year.[47] Chiropractors who care for older patients must take an active role in identifying patients at risk and actively engaging in the prevention of falls.

Risk Factors: Falls and Aging

Fall risk may range from quite simple to incredibly complex. Some examples of factors related to an increased fall risk are overall frailty, lower extremity or leg weakness, poor vision, balance disturbances, overmedication or improper medication, dehydration, blood sugar issues, depression, dementia, alcohol abuse, and social isolation, to name just a few.[48] Unfortunately, once a patient falls, they can also lose confidence and begin to restrict their activity, even when the injuries from the fall are not function limiting.[49] Indeed, loss of confidence and fear of falling can cause functional decline, depressed mood, frailty, and balance deterioration.[50] Falls clearly are a serious concern of both aging patients and their health care providers. We will now examine a case of a patient who sought out advice and care from her chiropractor after a fall.

A Chiropractic Case to Consider: George Feels Ninety

George turned 90 this year. He is a lively, bright retired teacher. He plays piano around town several times a week for various social functions. He lives alone in a retirement residence community in his own apartment. He is usually full of energy, but over the past few months he has been feeling more and more run down and unsteady on his feet. He says, "This must be what it feels like to be 90!" He visits his chiropractor for shoulder and hip pain resulting from a recent fall.

George has been hypertensive for 20 years, but controls his blood pressure with medication. He has taken a baby aspirin every day for 10 years, as per his medical doctor's advice, after what was thought to be a very mild heart attack. He also takes two medications for gastric reflux and occasional indigestion. He has had no hospitalizations over the past few years. He performs all activities of daily living by himself with no need of assistance; however, he did give up driving last year.

George has been under occasional chiropractic care for decades, and wants a "check-up," because he just doesn't feel his usual energetic self and knows that he has probably "knocked something loose" when he fell.

Why Did George Fall?

A thorough examination of the shoulder and hip was performed, which fortunately revealed no fracture or active pathology. His vital signs were normal, as were his orthopedic and neurological examinations. In assessing an older patient who has fallen, the SPLATT mnemonic may help to identify the cause of the fall. The following questions are asked of the patient:

- *Symptoms at time of fall:* Did you feel dizzy? Did you feel pain?
- *Previous falls:* Have you fallen many times or just this once?
- *Location where you fell:* Were you in the bathroom, kitchen, basement?
- *Activity at the time of fall:* Were you going to the bathroom? Walking? Looking up?
- *Time of day:* Was it in the afternoon (when hungry)? Or in the morning (low blood pressure)?
- *Trauma due to the fall:* Did you bump your head, land on your elbow, etc.?

In George's case, he was getting up from the breakfast table when he fell. He had not fallen recently, aside from a few years back when he stumbled up the stairs. He had been feeling dizzy lately in addition to his overall lack of energy. His blood pressure was slightly lower than is usual for him and further questioning reveals that he has been suffering from more heartburn than usual and that his stools have been darker than they had been in past years. He was not injured (beyond his pride and bruises) in the fall.

The Chiropractor Finds Out

The chiropractor was very familiar with George, and he was usually so energetic. His lack of energy worried him. He knew that some of his medications carried a risk of gastrointestinal bleeding, and he had been under treatment for reflux as well, so he ordered a simple blood test to check his hemoglobin. As suspected, George had gradually become anemic, and his lower blood volume in combination with his medications created a bit of orthostatic hypotension and he simply blacked out. A small gastrointestinal bleed was suspected, which was confirmed by additional testing once the chiropractor referred him to his medical doctor.

It is important to note that the older patient may assume that changes in health may just be due to "getting old." Any significantly negative change in health in an aging patient should be thoroughly assessed, however, to determine the cause and appropriate course of action.

Fall Prevention and Preventing Injury and Death Due to Falls

George's case represents some of the complexities of elder care and geriatric health. George's fall was not simply caused by weak legs or stumbling due to poor

vision, some of the more common causes of falls in older patients. Part of aging-related public health practice is to recognize major threats to healthy aging, such as falls, and to participate in associated evidence-based health promotion and prevention.

Screening for Fall Risk

All chiropractors can and should actively engage in screening for fall risk and recommend appropriate and relevant strategies to their patients to reduce their risk of falls. Regular and thorough histories and physical examinations must be performed to be vigilant for any potential health issues that could result in falls. It is important that recommendations be tailored to the specific health needs of the patient. Fall prevention is not a "one-size-fits-all" activity.

A basic screening for fall risk can be done simply and quickly in the chiropractic office. The simplest screening prioritizes identification of the high risk faller. The American and British Geriatric Societies emphasize screening by asking patients if they have had two or more falls or a single injurious fall in the last year. The guidelines also recommend a functional assessment called the Timed Up and Go Test. The doctor records the time it takes the patient to (1) rise from a chair, (2) walk 10 feet, (3) turn and walk back to the chair, and (4) sit back down. Healthy older adults should be able to complete this test in less than 10 seconds. A time over 29 seconds indicates difficulty with independent function in mobility. Fall risk increases with increased time to complete this test. Although there is no absolute cut-off value, a score of more than 13.5 seconds was found to have a sensitivity of 80% and specificity of 100% of predicting falls.[51] The examiner also gains valuable information while watching for unsteadiness during the Timed Up and Go Test, and unsteadiness is considered a positive screen in various fall prevention and risk assessment guidelines.[51]

Reducing Fall Risk

Because falls may be caused by underlying diseases, adverse medication effects, and other complexities, chiropractors should be in communication with the patient's primary care provider regarding fall risk reduction. Information gained by one provider should be shared with all, so that fall risk reduction strategies can be developed with the entire clinical scenario in mind. It truly takes a village to prevent falls, as the title of one recent article opines.[52] Lowering fall risk may be as simple as the medical doctor changing or lowering the dose of one medication, or as complex as a team of specialists managing multiple organ failure and the fall risk that comes with it. The chiropractic physician, due to his or her wellness/lifestyle orientation, close relationship and rapport with patients, and frequency of visits, may be well-positioned to work closely with a patient to address some of the fall risk issues that relate particularly to diet and exercise.

Exercise, Physical Activity, and Falls

Strategies for fall prevention may include therapeutic exercise, wearing proper footwear,[53] and utilizing appropriate ambulation devices to assist with mobility. Older adults with impaired mobility resulting from weakness in the legs (deconditioning) may benefit from a trial of exercise. Value may be found in both general physical activity, such as walking or aerobics, and specific exercises to strengthen a specific weak muscle or muscle group.[52,54] To be optimally effective, exercise needs to be tailored specifically to the patient's physical capabilities and needs. There is no magic formula related to exercise type, duration, and intensity that is proven to result in superior fall prevention. Tai chi, mentioned as a promising exercise for osteoarthritis, is also a promising exercise to improve balance and help reduce the fear of falling; its contribution to fall prevention requires further evaluation.[20,55]

Shoe type and fit is another important factor in fall prevention. Stability may be improved with shoes that have a thin, firm sole with moderate traction, rather than footwear with thicker soles, such as sneakers or running shoes. Thin soles provide better proprioceptive feedback, whereas thicker soles can result in tripping, especially in those individuals with a shuffling gait.[53]

For elders with gait and balance disorders, canes and walkers can be used to maintain or improve mobility. These ambulation devices increase the standing and walking base of support and stability, furnish proprioceptive feedback, and shift the load on weight-bearing joints (such as hips, knees, ankles, and feet) to the upper limb. Furthermore, devices provide the user with a visual presence of support that can instill confidence during ambulation, and thereby may help to reduce the fear of instability and falls.[49–52]

Fall Hazard Checklists

Most falls in older adults occur in the home.[30] A simple and inexpensive way to reduce the fall risk in the home is by using fall hazard checklists. Any number of versions of a fall hazard or home safety checklist can be found and downloaded through an Internet search. A checklist can be sent home with the chiropractic patient or their family and brought back for discussion on the

next visit. Examples of items that might pose a hazard to an aging adult in the home are poorly lit or cluttered halls or stairways, slippery floors or tubs, steps without handrails, loose throw rugs, and, in some cases, pets. Reducing fall hazards in the home has been shown to be effective in reducing falls.[52,56] See **Figure 14-1** for a checklist from the National Center for Injury Prevention and Control.[57]

Driver Safety

"Should grandpa still be driving?" This question is often asked by the family members of an aging patient. Children or grandchildren are often the ones voicing concern about the driving ability of their parent or grandparent, and the safety of passengers, pedestrians, and other vehicles exposed to their older driver. Although each state differs, most states require more frequent driving tests (annual) for very old drivers. In some cases, an older driver (e.g., an 80-year-old) must take an annual eye exam, written test, and driving test. In other states, only the eye exam and written tests are required. Of course, many younger citizens (particularly those who have had some negative driving experiences with an older relative) would advocate for a comprehensive driving test, to ensure safe driving among older adults.

Each year, thousands of older Americans fall at home. Many of them are seriously injured, and some are disabled. In 2002, more than 12,800 people over age 65 died and 1.6 million were treated in emergency departments because of falls.

Falls are often due to hazards that are easy to overlook but also easy to fix. This checklist will help you find and fix those hazards in your home.

The checklist asks about hazards found in each room of your home. For each hazard, the checklist tells you how to fix the problem. At the end of the checklist, you'll find other tips for preventing falls.

Floors: *Look at the floor in each room.*

Q: When you walk through a room, do you have to walk around furniture?

Ask someone to move the furniture so your path is clear.

Q: Do you have throw rugs on the floor?

Remove the rugs or use double-sided tape or a nonslip backing so the rugs won't slip.

Q: Are there papers, books, towels, shoes, magazines, boxes, blankets, or other objects on the floor?

Pick up things that are on the floor. Always keep objects off the floor.

Q: Do you have to walk over or around wires or cords (like lamp, telephone, or extension cords)?

Coil or tape cords and wires next to the wall so you can't trip over them. If needed, have an electrician put in another outlet.

Stairs and Steps: *Look at the stairs you use both inside and outside your home.*

Q: Are there papers, shoes, books, or other objects on the stairs?

Pick up things on the stairs. Always keep objects off stairs.

Q: Are some steps broken or uneven?

Fix loose or uneven steps.

Q: Are you missing a light over the stairway?

Have an electrician put in an overhead light at the top and bottom of the stairs.

Q: Do you have only one light switch for your stairs (only at the top or at the bottom of the stairs)?

Have an electrician put in a light switch at the top and bottom of the stairs. You can get light switches that glow.

Q: Has the stairway light bulb burned out?

Have a friend or family member change the light bulb.

Q: Is the carpet on the steps loose or torn?

Make sure the carpet is firmly attached to every step, or remove the carpet and attach nonslip rubber treads to the stairs.

Q: Are the handrails loose or broken? Is there a handrail on only one side of the stairs?

Fix loose handrails or put in new ones. Make sure handrails are on both sides of the stairs and are as long as the stairs.

Kitchen: *Look at your kitchen and eating area.*

Q: Are the things you use often on high shelves?

Move items in your cabinets. Keep things you use often on the lower shelves (about waist level).

Q: Is your step stool unsteady?

If you must use a step stool, get one with a bar to hold on to. Never use a chair as a step stool.

Figure 14-1 A home fall prevention checklist for older adults.* (*continued*)

Bathrooms: *Look at all your bathrooms.*

Q: Is the tub or shower floor slippery?

Put a nonslip rubber mat or self-stick strips on the floor of the tub or shower.

Q: Do you need some support when you get in and out of the tub or up from the toilet?

Have a carpenter put grab bars inside the tub and next to the toilet.

Bedrooms: *Look at all your bedrooms.*

Q: Is the light near the bed hard to reach?

Place a lamp close to the bed where it's easy to reach.

Q: Is the path from your bed to the bathroom dark?

Put in a night-light so you can see where you're walking. Some night-lights go on by themselves after dark.

Other Things You Can Do to Prevent Falls

- Exercise regularly. Exercise makes you stronger and improves your balance and coordination.
- Have your doctor or pharmacist look at all the medicines you take, even over-the-counter medicines. Some medicines can make you sleepy or dizzy.
- Have your vision checked at least once a year by an eye doctor. Poor vision can increase your risk of falling.
- Get up slowly after you sit or lie down.
- Wear shoes both inside and outside the house. Avoid going barefoot or wearing slippers.
- Improve the lighting in your home. Put in brighter light bulbs. Fluorescent bulbs are bright and cost less to use.
- It's safest to have uniform lighting in a room. Add lighting to dark areas. Hang lightweight curtains or shades to reduce glare.
- Paint a contrasting color on the top edge of all steps so you can see the stairs better. For example, use a light color paint on dark wood.

Other Safety Tips

- Keep emergency numbers in large print near each phone.
- Put a phone near the floor in case you fall and can't get up.
- Think about wearing an alarm device that will bring help in case you fall and can't get up.

Figure 14-1 A home fall prevention checklist for older adults.* (Continued)

*Reproduced with permission from the Centers for Disease Control and Prevention, the National Center for Injury Prevention and Control.

AARP offers a driving safety course for older drivers. It helps older drivers retain their driving privileges, if appropriate, and helps unqualified drivers give up the keys gracefully. These courses also share information with the older individual about public transportation options (if available in their area).

Families who are concerned about the driving safety of an aging family member may ask the chiropractor to take the lead in decision making or to suggest the revocation of driving privileges of their older family member. This is an incredibly sensitive issue, with Health Insurance Portability and Accountability Act (HIPAA) ramifications; however, if a chiropractor detects health issues that could result in unsafe driving, he or she should be willing to express such concern to the patient immediately. Examples of such health issues are poor visual acuity, significant hearing impairment, compromised balance or coordination, confusion, episodes of fainting or dizziness, or significant upper body weakness.

A DISCUSSION OF LIVING OPTIONS: CHOICES FACING FAMILIES

Most people over age 65 in the United States live at home, on their own or with family members. Less than 5% of aged individuals live in nursing care.[1,2] The vast majority of people over 65 are completely able to care for themselves and perform all activities of daily living without assistance; even among those over 85 years old, most can function completely independently. However, for those who need a little bit of care or some help in caring for themselves or their home, a wide range of services and choices are available. This discussion is included in this chapter because chiropractors develop excellent rapport with their patients and subsequently may be conferred with regarding housing options in their community for a patient or aging relative. This section is not traditionally referenced. All information was taken from resources given in the "Health Resources for Older Patients and Health Professionals" (see **Table 14-1**).

Table 14-1 Health Resources for Older Persons and Health Professionals

AARP
1-888-OUR-AARP
http://www.aarp.org
Alzheimer's Association
800-438-4380
http://www.alzheimers.org
American Cancer Society
800-ACS-2345
http://www.cancer.org
American Heart Association
1-800-AHA-USA1
http://www.americanheart.org
American Society on Aging
415-974-9600
http://www.asa.org
Arthritis Foundation
800-283-7800
http://www.arthritis.org
Elder Housing Information
http://www.eldercarelink.com
International Association for Hospice and Palliative Care
http://www.hospicecare.com
Mental Health Internet Resources
http://www.mentalhealth.org
National Council on Aging
202-479-1200
http://www.ncoa.org
National Institute on Aging
800-222-2225
http://www.nih.gov/nia
National Osteoporosis Foundation
202-223-2226
http://www.nof.org
National Stroke Association
800-Strokes
http://www.stroke.org
Senior Housing
888-539-1150
http://www.senioroutlook.com
U.S. Preventive Services Task Force
301-584-4015
http://www.ahrq.gov/clinic/USpstfix.htm

Adult Day Care

Adult day care is a planned program of activities designed to promote well-being though social and health-related services. Adult day care centers operate during daytime hours, Monday through Friday, in a safe, supportive, cheerful environment. Nutritious meals that accommodate special diets are typically included, along with an afternoon snack. Adult day care centers can be public or private, nonprofit or for-profit. The intent of an adult day care center is primarily two-fold:

- To provide older adults an opportunity to get out of the house and receive both mental and social stimulation
- To give caregivers a much-needed break in which to attend to personal needs, or simply rest and relax

There are currently approximately 4000 adult day care centers nationwide, according to the National Adult Day Services Association (NADSA). As our society ages, increasing numbers of adult day care centers will develop.

Good candidates for adult day care are seniors who:

- Can benefit from the friendship and functional assistance a day care center offers
- May be physically or cognitively challenged, but do not require 24/7 supervision
- Are in the early stages of Alzheimer's disease

An adult day care center may look more like small town Main Street than a "facility," with shops and activity rooms wherein visitors can gather to play bridge, have a cup of coffee, have their hair done, work in a community garden, or do arts and crafts, among other things. The reader is encouraged to identify and learn more about such services in your area.

Independent Living: Senior Housing

A great place for an older adult to live in the community is a "retirement village" or independent living complex. Independent living communities are designed to enable independent seniors to enjoy a lifestyle filled with recreational, educational, and social activities among other seniors. The usual policy is no persons under the age of 50 may rent or buy property within this type of housing environment. Such "villages" may also offer an array of continuing care options, as described in the next section.

Continuing Care Communities

Continuing care communities allow an older adult to transition, within a single housing community, from independent house or apartment living to assisted living, to nursing care, if need be. Such cafeteria-style housing areas exist in any sizable city or suburban area. Continuing care housing options may require a significant down payment (for example, in Iowa it could range from $60,000 to $200,000) and high monthly payments

or rent (for example, $800–$2500/month or more). However, those rates cover all housing needed through the end of life, including unlimited years of nursing care if needed, some or all meals, and virtually all medical expenditures through the end of life. This offers a person who wishes to give up their home a secure option that relieves family members of the burden of decision making and costs of housing and health care for aging relatives.

Assisted-Living Apartments/Residences

Assisted-living provides a special combination of residential housing, personalized supportive services, and health care. These residential settings maximize independence, but do not provide skilled nursing care. Assisted living may offer the same features as independent living or retirement communities, with the added assistance of personal care. It is designed to meet the individual needs of those requiring help with activities of daily living, but who do not need the skilled medical care provided in a nursing home. Although the variety of services and level of care may vary, most communities provide assistance with dressing, grooming, bathing, and other daily activities. Assistance with medications varies by state.

Assisted-living communities can be free standing; part of a continuing care community that provides independent, assisted, and nursing care; affiliated with a nursing home; or a specialized service brought into an independent retirement community. These residential settings maximize independence, but do not provide skilled nursing care.

Costs for assisted living depend on the number of services and accommodations they offer. The facility's charges will reflect the number of services residents have access to and may be similar to the continuing care costs described earlier.

Nursing Home Care

Care in a nursing home anchors the end of the housing option spectrum, and is reserved for those patients who need 24-hour nursing care and assistance with many or all of their activities of daily living such as toileting, dressing, bathing, and feeding. Fees for nursing care provide room and board, with meals planned by medical staff; personal care; protection; supervision; housekeeping; and sometimes other types of therapy. Nursing homes' on-site medical staff sets them apart from other types of senior housing. Nursing care is provided by registered nurses (RNs), licensed practical nurses (LPNs), and nurses aides at all hours of the day and night.

Nursing homes are licensed and regulated by state departments of public health and are individually certified by the state for Medicare and Medicaid. They offer a staff of licensed and/or registered nurses, nursing aides, and administrators as required by licensing standards. The health care is supervised and authorized by a physician. They must also meet federal requirements.

Nursing homes charge a basic daily or monthly fee. According to AARP, the average cost of nursing care in the United States is $5660/month, but it can be up to $40,000/month if specialized care is needed long term. Some families purchase long-term care insurance in anticipation of the cost, whereas others must depend on other forms of financing. Facilities accept a variety of payment sources including Medicare, Medicaid, private insurance carriers, and private funds.

The quality of nursing care facilities ranges greatly; some items for consideration in choosing nursing care include the following:

- Does this facility appear to have qualified, pleasant staff/personnel?
- Is the facility clean and do the patients appear to be well-cared for?
- Does this facility allow unannounced visits by family members and friends?
- Does this facility create opportunities for interaction with animals and children?
- Does this facility use restraints on its patients? (If so, look elsewhere for care.)

Hospice Care

Hospice is primarily a concept of care, not a specific place of care. Hospice care is provided to patients who have a limited life expectancy; it is considered end of life care. Although most hospice patients are cancer patients, hospices accept any terminal patient regardless of age or type of illness. These patients have also made a decision to spend their last months at home or in a homelike setting. Hospice emphasizes quality rather than quantity of life, wherein the dying are comforted. Professional medical care is given, and sophisticated symptom relief provided. The patient and family are both included in the care plan, and emotional, spiritual, and practical support is given based on the patient's wishes and family's needs. Trained volunteers can offer respite care for family members as well as meaningful support to the patient. Care given in hospice is designed neither to hasten nor to postpone death. The goal of the hospice team is to be sensitive and responsive to the special needs and wishes of each individual and family.

CONCLUSION

The cases and discussions in this chapter represent an overview of public health practice with an emphasis on the aging patient. Additionally, this chapter has provided chiropractors with resources with which to better provide services to and advocate for their older patients. The authors hope that this chapter has included information relevant to DCs, in both the educational and clinical setting.

There has never been a more important time in history to learn about and get better at care of the aging patient. The complexities and challenges of geriatric care certainly do not outweigh the joys and blessings of providing care for our elders. As providers, we must take care in preventing "ageism" from creeping in, and with it preconceived or stereotypical notions about the aging patient and the care they should or shouldn't receive. Ageism, if allowed to guide us, would say, "Why bother sharing health information, or recommending lifestyle changes? They're old! They're never going to change!" But, these thoughts could not differ more from the science and truth of the matter. Several authors have written volumes about patient compliance issues. They all remind us that of all age categories, the aging patient is the *most* compliant patient of all.[56,58] So, offering sound health recommendations to our older patients is very worthwhile, has the best chance of being effective, is gratifying, and is very much appreciated by the aging patients themselves.[59]

This chapter has emphasized that public health activities related to aging come in all shapes and sizes, from very simple to infinitely complex. There are also opportunities to engage in public health efforts at the local, state, and national level. As our world "comes of age" and the effects of the "silver tsunami" are felt throughout the health care system, it is essential that providers, policy makers, and patients all work collaboratively to ensure that we will have the opportunity to age well, together.

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CHAPTER
15

CHAPTER OUTLINE

Population Health

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Although the electronic age, improved transportation, technology, and changes in the global economy have brought humans closer together than ever before, massive disparities in the health of nations, ethnic groups, and social classes still remain.[1] The United States and other developed countries are characterized by aging populations, reproduction rates below the population replacement rates, and the immigration of people from less developed countries.[2] Many other countries have different profiles, but a common one where poverty is prevalent is to have a young population with a high mortality rate, declining birth rates, and low immigration rates. Such is the profile of sub-Saharan Africa, where half of the people live in extreme poverty, one third live in hunger, and one sixth of the children die before the age of 5.[1]

Clearly, with such disparities, a one-on-one approach to health will not work.[3] In health care, the focus of attention (unit) is the person, who is usually in the office to see a health care provider for a health care problem. Thus, health care focuses on a single patient to cure a specific problem. Conversely, in public health, the unit is a large group of people, such as a community, and the focus is on preventing death or disease. These two approaches are complimentary, rather than mutually exclusive. For example, in the office, a chiropractor can educate his or her patients during clinical encounters about the benefits of smoking cessation. From a public health perspective, the same chiropractor could develop or participate in a community program focused on developing smoke-free environments, thereby preventing thousands of people from being exposed to second-hand smoke.[4]

The field of public health still works diligently to prevent the spread of infectious diseases. With diseases such as avian flu,[5] human immunodeficiency virus (HIV), and malaria[1] being very real threats to millions of people

*The views expressed in this publication are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, or the United States Government.

around the globe, this focus must continue. However, it is also widely recognized that chronic diseases with modifiable risk factors are leading causes of death (*mortality*) and disease/disorder (*morbidity*) in many countries.[6,7] Unfortunately, many people have come to rely on the health care system to fix their health problems rather than exercising good judgment and modifying their health behaviors to prevent being afflicted by chronic diseases, such as hypertension and heart disease.

The application of population health concepts toward specific conditions such as chronic or musculoskeletal disorders is relatively new. Recent collaborative programs, such as the Bone and Joint Decade 2000–2010 (http://www.boneandjointdecade.org and http://www. usbjd.org), have raised awareness of these issues. For example, Cassidy and Cote[8] performed a best-evidence synthesis to evaluate population approaches to prevention and treatment of neck pain. They found that only 8 out of 552 published studies addressed population health issues related to neck pain, even though neck pain is recognized as a major public health burden. It will be important for future research to be performed at the community and population levels in order to better prevent and control conditions such as neck pain or other common conditions that are addressed and managed by chiropractors.

Some of the terms used in public health are not well understood, and often people will erroneously use words with specific meanings as synonyms.[6] Such is the case with the terms *public health*, *population health*, *community health*, and *population medicine*. Unfortunately, public health is not well defined in the literature, even by people who practice it. In this chapter, when we refer to *public health*, we are discussing organized group efforts that are focused on preventive measures to improve the health of large groups of people and involve assessment of a health problem and the development of policy.[9] Public health is linked to a social justice philosophy, is political, and addresses many agenda items.[10] Thus, public health is essentially an action or movement, rather than a status. *Community health* is concerned with the actions taken to promote, preserve, and protect health in a community and that community's health status.[11] A community is a defined group of people who have interests or characteristics in common; communities are not restricted to geographic locations. Examples of communities could be a college campus, members of a health advocacy group, or those in the U.S. armed services. *Population health* is similar to community health, except that the group has no identity as a group or locality. Examples of populations are women older than age 50, pregnant teenagers, or people who have degenerative joint disease. Thus, population health is composed of the actions taken to promote, preserve, and protect health in a nondefined group and that group's health status.[11] *Population medicine* is the investigation of the distribution and determinants of health and disease, mortality, and morbidity in populations, and is also known as *epidemiology*.[7]

POPULATION HEALTH ISSUES

A variety of factors must be considered when focusing on the health of populations. *Health disparities* exist when there is inequality in accessing health care and there are variances in the quality of health in various subsets of a population. Determinants of health are those factors that impact the health of the individual and the population. These include the conditions in which people live as well as individual characteristics that are modifiable (e.g., environment, behaviors) and not modifiable (e.g., age, sex, genetic background). Social determinants of health are typically those that relate to socioeconomic factors that impact health (e.g., social, economic, political).[12] Examples of social determinants may include access to health care, safe drinking water, supportive social networks, safe housing, healthy work environments, and access to healthy food. Individual determinants of health are those factors that are specific to individuals, such as personal choices (e.g., behaviors, attitudes) and attributes (e.g., sex/gender, age, race).[13] Both combined make up the determinants of health (**Figure 15-1**). This section will address some of the major issues that impact population health.

Health care practitioners typically focus on individuals by providing care, counseling, and interventions to individuals. Usually in the world of health care practice, the individual patient is at the center of all processes. This is commonly known as patient-centered practice, and is a major component of evidence-based practice.[14,15] In the public health arena, the social structure and the greater public health care needs are at the center, resulting in a focus on the "greater good" of the community.[10] Therefore, the focus for population health is not an individual person or patient. The interactions and measurements of populations and the broader social condition are more complex than that of the individual. Therefore, the interventions to modify them are more involved and can be more costly than those focusing on the individual.[12]

Historically, the foundation of medical research and science has been primarily scientific and therefore has used a reductionist method to measure health outcomes.[16]

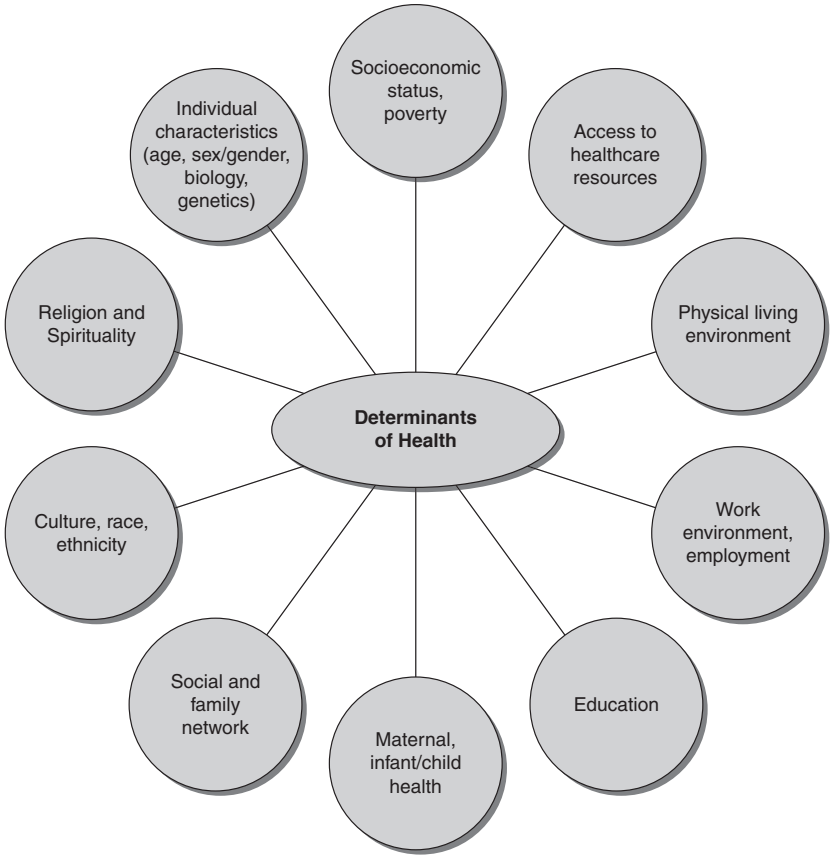

Figure 15-1 Determinants of health.

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This typically results in a focus on only the parts or diseases, instead of the whole person or population, and has been ineffective in many cases.[16] There has been a paradigm shift from focusing on simplistic risk factors for individuals to that of a more complex model in which biological, psychosocial, and sociocultural effects that contribute to health and disease are the focus,[16] resulting in a more holistic and qualitative approach to both individuals and populations.

Chiropractic is a profession that has traditionally approached patient health from a holistic standpoint, without the use of drugs or surgery. Many doctors of chiropractic also collaborate with other providers as part of the health care team to provide the best possible patient care. Chiropractic's historical approach has focused on the patient's innate, homeostatic powers of the body to heal itself, which may include physical, psychosocial, emotional, and/or spiritual components.[17] As stated by the founder of the chiropractic profession, D.D. Palmer, "Functions performed in a normal manner and amount result in health. Diseases are conditions resulting from either an excess or deficiency of functioning."[18] Thus, the chiropractic profession embraced a broad definition of health long before the World Health Organization adopted its definition in 1946, which states that health is, "[a] state of complete physical, mental and social well-being, and not merely the absence of disease."[19]

Chiropractic is a part of the global web of health care, and we are in a position to contribute to population health. Each community is a complex mixture of peoples, cultures, and environments. Therefore, unidimensional solutions are not likely to make a difference in overall health. Multifactorial and teamed approaches to community needs are the best method. As health care providers, we must learn about our communities' needs and be prepared and willing to help. We must become aware of how to be more involved in our communities and work within the larger health care and public health

environment. Even a small amount of effort can make a difference, if it is applied appropriately.

SOCIOECONOMIC STATUS AND POVERTY

Socioeconomic status has an influence on behavioral and psychosocial risk factors for disease.[16] Causes (e.g., environmental, behavioral), access to health care, and means for treatment and prevention are affected by socioeconomic status.[16] If we have a better understanding of these factors, we can attempt to address them through programs at both policy and social levels. Socioeconomic status is linked to health disparity; however, there are challenges in measuring outcomes.[20] Shavers offers a composite model that may help us better measure and understand class and the dimensions of the social processes of class. The three categories in Shavers' model are occupation (employment status, occupational groups), education (years of education, highest degree obtained, credentials), and income (individual, household, family income). When approaching population health issues, these three characteristics should be identified and addressed.

Poverty has a devastating impact on health,[21–23] and has been associated with a variety of health conditions. The National Center for Health Statistics[24] has shown that a significant number of families in the United States live below the poverty level. Poverty impacts health and disease in numerous ways, including financial barriers, health care system challenges, attaining education, and living conditions.[25,26] Financial barriers may include low household income, which influences the ability to purchase health care, nutritious food, clean water, heating, and the means for good hygiene. Health care system barriers may include fewer services available, less ability to access these services, a lack of understanding of how to access health services, fewer preventive or treatment services available, and slower delivery of necessary services. Educational level barriers impact a person's ability to read warnings or prescription instructions, to have a basic understanding for nutritional needs, comprehend safety and hygiene knowledge, to seek health care services, and to find work in safe and healthy environments. Living conditions for those in a poverty state are challenged by a lack of adequate clean water, toxic environments (e.g., lead paint, asbestos), lack of proper sanitation, and an increased exposure to disease vectors (e.g., mosquitoes and malaria if no bed nets).[25,26] These issues have a direct influence on the physical and mental health of those living in poverty.[16]

To address global issues of poverty, the United Nations Development Program has provided a plan to significantly reduce world poverty by the year 2015.[1] This plan describes eight measurable goals:

1. Eradicate extreme poverty and hunger (e.g., halve the proportion of people whose income is less than $1/day).
2. Achieve universal primary education (e.g., boys and girls will have access to primary schooling).
3. Promote gender equality and empower women (e.g., eliminate gender disparity in primary and secondary education).
4. Reduce child mortality (e.g., reduce the under-5 mortality rate).
5. Improve maternal health (e.g., reduce maternal mortality by three fourths).
6. Combat HIV/AIDS, malaria, and other diseases (e.g., halt the spread of these diseases).
7. Ensure environmental sustainability (e.g., introduce sustainable practices and clean drinking water).
8. Develop a global partnership for development (e.g., develop a plan for the future).

For more information, visit the United Nations Development Program website (http://hdr.undp.org/en).

In the year 2000, nearly 200 countries joined together to adopt the United Nations Millennium Declaration. From this, the Millennium Development Goals were formed; they include freedom, equality, solidarity, tolerance, respect for nature, and shared responsibility.[1] It is hoped that by reducing poverty, improving education, and enhancing health, the people of the world will better develop mental and physical health and become more productive. The Millennium Declaration describes human development goals as capabilities, which include living a healthy life, education, standard of living, freedom to participate in community governance, and improved conditions (sustainable environment, sex/ethnic equity, support for a global economic environment).[1] Even though clear goals have been set to end human poverty, such as with the *Millennium Development Goals: A Compact among Nations to End Human Poverty*, these targeted goals are not being reached at the rate that was originally hoped.[1] Modification of population behaviors may take years to accomplish, and a multi-pronged approach is needed. We must be aware of the many factors associated with public and population health in order to make a difference.

In areas of most severe poverty, a more holistic and/or natural approach (e.g., chiropractic care) might be

welcomed to join with ongoing health care efforts in the areas of need. Recently we have observed a shift in practices of allopathic medicine to a more holistic and patient-centered approach. Thus, the approaches of mainstream care seem to be becoming more aligned and collaborative with the chiropractic approach. As an example, Kopansky-Giles et al.[27] describes how chiropractic care has been integrated within a collaborative community-based teaching clinic in order to address the needs of local poor communities. Their project demonstrated high utilization, good clinical outcomes, high patient satisfaction, and collaboration of care with other health practitioners. At one of their locations, St. Michael's Hospital, the St. Michael's Inner City Health Program combines the Department of Family and Community Medicine with the Canadian Memorial Chiropractic College program (**Figure 15-2**). After an initial demonstration project was complete, the success of the program resulted in a permanent chiropractic program being included at this location. Demonstration of successful integrated projects such as this one may provide a model for other locations to develop integrative programs to better serve our poor communities.

ACCESS TO HEALTH CARE

In an ideal world, all members of society would be living in optimum health; however, there are times when health care is needed. Unfortunately, our current health care systems focus more on the treatment of disease instead of on disease prevention and health promotion.[23] Harvey suggests that we are currently spending our limited health care resources on acute and chronic illnesses, instead of using our resources to develop more healthy communities.[23]

Adequate access to health care can determine the overall health of a population. Economically poor subpopulations have fewer choices for healthy lifestyles and may not have adequate access to care. Delay in receiving proper treatment may increase suffering or may result in permanent disability or death. Various barriers may prevent people from accessing care. Care may be unaffordable, not available, or there may be various behaviors to avoid accessing care. Barriers to care may relate to other determinants of health. Those living in an area with few resources may have poor transportation; therefore, those in the community may not have the means to access care. Those in a lower economic group may lack funds or insurance coverage to pay for necessary care. In some areas of the country, there is a scarcity of health care providers. Lack of education may result in a lack of proper information about health conditions, prevention, or how to seek care. For various racial/ethnic groups, language barriers and social customs may prevent care-seeking behaviors or confidence in the doctor-patient relationship.

Chiropractic may provide some ways in which barriers to health care can be reduced. Some may consider

Figure 15-2 **St. Michael's Hospital, location of a successful integrated program to assist poor communities.**

Source: Reprinted with permission from the JMPT. Kopansky-Giles D, Vernon H, Steiman I, Tibbles A, Decina P, Goldin J, Kelly M. Collaborative community-based teaching clinics at the Canadian Memorial Chiropractic College: addressing the needs of local poor communities. *J Manipulative Physiol Ther.* 2007;30(8):558–565.

chiropractors more accessible, friendlier, less intimidating, and holistic, and therefore may choose to visit their local chiropractic office for a variety of their health care needs. In some cases their care may require medical attention, in which case the chiropractor would appropriately refer or comanage care for the patient. If chiropractors were more integrated within the larger health care system, individuals would be able to enter the health care system through chiropractic services and be able to access appropriate care for all their health care needs. Stevens[28] evaluated various behavioral and access barriers to seeking chiropractic care in the New York area. In this population, he found that transportation, cost, insurance, and behavioral barriers resulted in delay of care. In 2003, Smith and Carber[29] evaluated the contribution of the chiropractic profession from a variety of sites across the US (**Figure 15-3**) in meeting U.S. health care workforce needs. They found that the amount of charity care provided by chiropractors approximates that provided by medical physicians. Their findings suggest that U.S. chiropractors serve a vital role in the health care safety net.

PHYSICAL LIVING ENVIRONMENT

The environment in which we live determines what risk factors we are exposed to. Various factors make up our living environment and have the potential to support or harm our health. The air we breathe may be clean or it may contain allergens, mold, toxic chemicals, radon, smoke, and other harmful gases or particulate matter. The building materials that are used to construct our homes, schools, and workplaces may expose us to harmful chemicals, such as asbestos, lead, or formaldehyde. Cleaning products or pesticides that we use in the

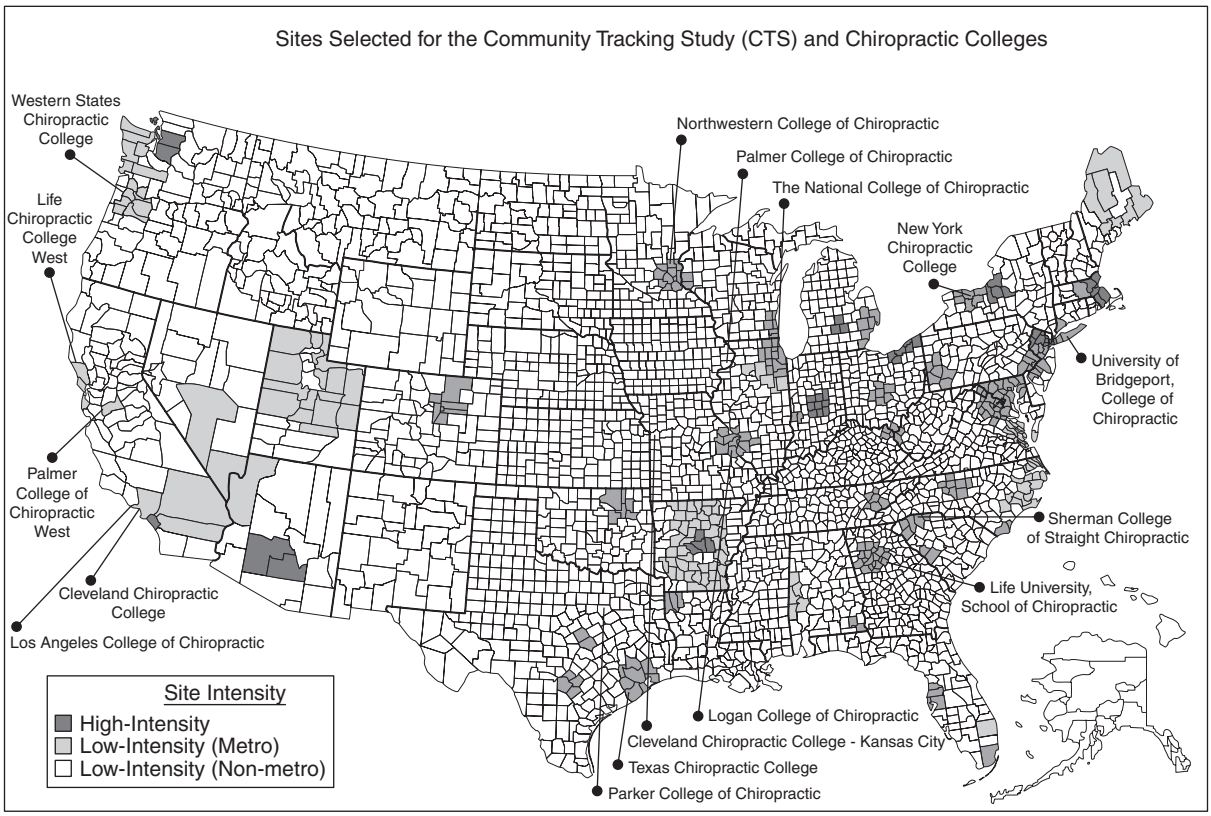

Figure 15-3 **A map of randomly selected chiropractic college locations of the Community Tracking Study conducted by the Center for Studying Health System Change.**

Source: Reprinted with permission from the JMPT. Smith M, Carber LA. Chiropractors as safety net providers: first report of findings and methods from a U.S. survey of chiropractors. *J Manipulative Physiol Ther.* 2007 Nov–Dec;30(9):718–28.

home or workplace and living areas may contain harmful chemicals that may result in short-term or long-term effects, such as cancer.[30]

Other environmental issues include human and industrial waste. Often, areas around waste processing plants or industrial zones will house poorer socioeconomic populations. Waste contamination from these industries in the air or water runoff may be harmful to those people who live close to these areas; therefore, these groups carry a heavier health burden due to these exposures. As well, impoverished areas tend to have poorer control of pests that carry diseases. Flies may carry typhoid and cholera; mosquitoes may carry encephalitis, malaria, and West Nile virus; and rodents can carry hantavirus and salmonellosis.[30]

There are a range of health issues relating to water and food safety. Some rural or impoverished areas have difficulty supplying safe drinking water and enough water for proper hygiene and human waste disposal. Access to safe and uncontaminated food is also a problem. Sometimes the contamination may occur at the food source (e.g., salmonella, *E. coli*) or because of the inability to properly store food due to lack of refrigeration or proper storage methods, or may occur due to a lack of education about how to prevent contamination. The types of foods available to a subpopulation can also impact health. A wealthier community may have access to fresh fruits, vegetables, and a variety of other healthy foods, whereas a poorer group may have a higher proportion of fast food restaurants and little access to fresh produce. Reduced access to healthy food and a high density of fast food restaurants has been associated with more unhealthy behaviors and obesity.[31,32]

Physical activity and social interactions promote overall physical and psychosocial health. Communities with a poorer socioeconomic status may suffer with higher rates of crime, more violence, reduced physical activity, and higher psychological stress.[33,34] Providing safe environments where healthy activities may occur is challenging but necessary. Overall, the multiple complex characteristics of our living environment have a direct impact on the health of a population.

WORK ENVIRONMENT AND EMPLOYMENT

If one works in an environment that is hazardous, then one is more likely to experience injuries associated with those specific hazards. If a worker does not have the education or income to access education and training, then less desirable jobs are the only ones available. This leaves workers with lower socioeconomic status to have jobs that may expose them to greater hazards and health risks. Some examples of occupational injuries that have a clear link with cause and effect include lung disease in coal miners, known as coal workers' pneumoconiosis (anthracosis), and mesothelioma/asbestosis in asbestos factory workers. Other health factors may not be so clear cut. Ahrens[35] mentions a study in which multiple factors (alcohol and smoking), in addition to the workplace, were linked with laryngeal cancer. A study in Sweden found a correlation between occupation and coronary heart disease.[36] It is interesting to note that even in a country such as Canada, whose citizens regardless of socioeconomic status have access to health care, poor health outcomes were significantly linked with socioeconomic status.[37]

Especially in the area of neuromusculoskeletal conditions, chiropractic may be of service. According to the Centers for Disease Control and Prevention (CDC), musculoskeletal complaints account for a significant portion of occupational injuries and illnesses each year. A 1997 report by the National Institute for Occupational Safety and Health (NIOSH) released the following data: injuries due to overexertion in lifting (65% affected the back); injuries due to overexertion in pushing or pulling objects (52% affected the back); and injuries due to overexertion in holding, carrying, or turning objects (58% affected the back).[38] Specifically related to the work environment, it is suggested that neck pain may be associated with computer use[39] and physical exposure and stress may increase musculoskeletal injuries.[40] Evaluation of ergonomic and work environment factors may help us in creating safer and healthier work environments.

EDUCATION

Level of education has been connected with health outcomes. For example, Jemal et al.[41] analyzed 2001 U.S. national mortality data and found that educational levels correlated with higher mortality rates. Although the total deaths associated with lower educational status were not associated with any particular race or ethnic group, they found that Black men and women had the highest death rates from many causes at nearly all levels of education. This implies that determinants of health do not work alone, but interact with one another.

Those with higher levels of education may be more likely to have better jobs, more knowledge, or better access to health care and resources. Education may also influence behaviors in the physical and family environment. For example, Bere et al.[42] found that parent education and income influenced the fruit and vegetable intake of their children. Education also has an impact on people's ability to read or communicate in written and spoken language. A person who can read at the fifth grade level may not understand scientific articles published at the college level. As well, because someone is educated at the graduate level in one language and culture (e.g., Chinese or Spanish) does not necessarily mean that this person is fluent in other languages. For example, providing health care information or instructions in English to a non-English speaker, no matter how educated the person is, will likely result in confusion and misunderstanding. We must be sensitive to the various educational levels and be prepared to meet the needs of the population.

MATERNAL, INFANT, AND CHILD HEALTH

Maternal and child health and mortality, especially as they relate to socioeconomic status, are concerning issues. There is a proportional relationship between child health and mortality and poverty level.[25] According to Victora et al.,[25] factors that influence children's health include ". . . inadequate water and sanitation, indoor air pollution, crowding, poor housing conditions, and high exposure to disease vectors." Children who are undernourished are more prone to illness (e.g., nutritional diseases and reduced immune systems leading to infections), and maternal health during pregnancy and breastfeeding may impact the health of the child.[25,26] Access to health care for children and infants may be affected by a lack of local health care support systems; parents may not have access to health care or may lack knowledge of how the local health care system works or what activities (e.g., handwashing or offering a balanced diet) could make a difference.[25,26]

Programs and policies on a local or national level could be developed to address the issues that influence maternal and child health and mortality. Educational systems could be developed to train mothers about early childhood nutrition and handwashing, or local policies could help support clean water supplies or methods to access available health care.[25] Wagstaff et al.[26] suggest solutions that may include policies impacting income, education for better managing child health within the home, dedicating resources to services for conditions of highest relevance, and programs dedicated to improving hygiene. Szilagyi and Schor[43] recommend that special attention be given to children at risk and that we need to recognize which factors put children at risk. Factors may include social and economic factors, such as families under stress, homelessness, and economic challenges. If problems can be identified and measured accurately, we might be able to better guide effective health care and social programs and address these issues.

SOCIAL AND FAMILY NETWORKS

In order to succeed in health promotion programs, we must understand the complex nature of the individual and how the individual is a part of the greater social structure, such as the family and society. There are strong connections between health and family and social factors.[44] Examples of social and family factors may include the social impact of divorce on the mental health of children[45] and the characteristics of parents and family that influence access to health care. In addition, there is a relationship between improving socioeconomic structure and access to health insurance.[46] Families are an important component of the social network in that they provide members with physical, emotional, and financial support. We need to look beyond the individual and better understand the social and supporting structure so that our planning in health promotion may more appropriately match the changing family structure.[47]

The basic family structure has changed over the past century.[47] Family systems that may once have consisted of core members may now rely on extended family members or are now fragmented or rely on nonrelatives for family-like relationships. This changes the network of people that the family members are exposed to and therefore changes the psychosocial interactions, which may result in changes to psychosocial health. With these types of changes, it is important for us to understand and identify key factors that support family resilience, which is the ability for a family to adapt and succeed during a state of change or adversity.[48] Walsh[48] suggests that our focus should be on family strengths instead of weaknesses, and that health and prevention programs should be developed with this construct in mind.

Social support networks are complex; thus, understanding various models may be helpful in identifying the social support networks in a community. Several researchers have described methods for defining and

measuring the quality and depth of social networks. Lin and Son[49] describe a social network as having three layers: interactions with community, an extended family/social network, and immediate family and close/intimate relationships. Berkman[50] describes Boissevain's work in cultural anthropology that includes a multiple layered model with six concentric circles surrounding an individual, ranging from an extended and nominal zone to an intimate and personal zone. In a model proposed by Pescosolido,[51] the complex layers include the physical health of the individual in addition to the individual and community network. Each of these models may help us better understand social networks.

Before incorporating social networks into a public health program, it is important to understand the specific target community, because each community is different. Measurement tools may be used to identify the components of the social support networks. Examples of tools may include the Social Network Index,[50] Social Networks Inventory,[52] and Social Network Questionnaire.[53] Each focuses on a different aspect of social networks, depending upon the interest of the researcher. If a community has an exceptionally strong network within a particular area (e.g., education, religious, career/job, family, neighborhood), that particular facet may be the best mode in which to address a program or deliver a health promotional activity.

Community-based interventions have the potential to impact health improvement.[16] In order to plan to improve community health promotion programs, we should understand what "community" is. Heller[54] suggests that communities are multifaceted, and each individual belongs to multiple communities. To find the right tools, we must understand the community framework. McLeroy et al.[55] propose further classification of the community-based model into four categories. One category is defined by the geographic location or setting. In this category, tools focus on the individual as the target of the intervention. Community may also be defined as the target; thus, these interventions aim at changing the statistics of the community as a whole. The third category is the community as a resource. This assumes that community participation will ultimately impact overall health; thus, modifying the community is expected to improve health. The fourth category identifies the naturally occurring components in a community that may be used as agents of change. In this category, a carefully considered evaluation is required to utilize the system that is already in place so as to maximize positive impact and minimize disruption of the existing system. Each of these approaches should be considered when developing tools and strategies for change.

There appears to be an increasing awareness that integration of a multitude of tools and components into health programs is needed. We need to be thoughtful when considering which tools to use when planning for health promotion programs.

CULTURE, RACE, AND ETHNICITY

Culture is a collective representation of a group's beliefs and attitudes.[56] When a group migrates to a new location, the transformation and change of a minority group's culture to the dominant society's culture is termed "acculturation." There are various viewpoints about how acculturation occurs. Models include linear or bimodal ones as well as models in which the minority culture changes compared to reciprocal models where change also occurs in the dominant culture.[57]

Acculturation impacts health and behaviors in minority groups. In some instances acculturation may be protective, but in others it may be detrimental.[58] Latinos represent the largest minority in the United States, and therefore we need to address this substantial component of our population.[59] Acculturation studies show that Mexican American immigrant children have less asthma symptoms than other minority groups; however, through acculturation the incidence of asthma is increasing, but specific factors are unclear.[60,61] Further, McMullin et al.[62] evaluated how specific beliefs of Latinas may impact the behavior of preventive practices and regular screening tests. They discovered in this research that there was a cultural belief that certain sexual activities and poor hygiene caused cervical cancer and that only women who had symptoms of pelvic infection needed to have a Pap smear test. This prevented Latinas from getting regular checkups. To address this, a program to improve preventive health practices by including education to address core beliefs (e.g., that cervical cancer is not symptomatic and one should not wait until symptoms are present) and to deliver this message in a culturally competent manner (e.g., language, manner, method of delivery) would be important.

Juckett[56] suggests that if a health care provider approaches a patient in an ethnocentric manner (i.e., in a manner that assumes his or her culture is superior), it hinders providing effective care. The same could be said for how we approach public health programs and policies. Approaching various groups in an ethnocentric manner (i.e., that our culture is superior) will be ineffective in achieving our goals. We must be culturally competent if

we are to develop successful policies and programs, and implement an efficient public health infrastructure.

Physical and mental health burdens are carried differently by various subsections of our minority populations.[24] For example, when comparing the percentage of undiagnosed cases to the overall percentage of those with diabetes for 2001 to 2004, there are differences in the ethnic groups. Using age-adjusted data of those with diabetes (both diagnosed and undiagnosed cases), African American and Mexican American groups had been diagnosed with diabetes at a rate of 78% compared to only 68% of the White population.[24] For psychological distress, 2.3% of the White-only population is reported to have distress compared to 3.4% for African Americans, 5.5% for Native Indians, and 9.1% for those reporting an ethnic background of two or more races.

Abraido-Lanza et al.[57] suggest that the impact of culture on health is complex. They suggest that acculturation into the larger community is not always predictable. For example, Latinos merging into the U.S. culture may not necessarily gravitate to the "White" culture. Instead, some of the younger Latinos may be drawn to the culture of "Black inner-city youth." When a minority group is in the process of acclimatizing to the environment, there are multiple options from which they must choose. One may not be able to adopt the culture of both "Whiteness" and "Blackness" in addition to retaining or modifying one's native culture, so it is possible that this environment creates friction and induces stress. This is important for us to consider when approaching these issues.

Race is the categorization of an individual based upon visual identification such as skin color. Ethnicity is made up of values, cultural norms, and behaviors. Both race and ethnicity are factors in health and well-being.[63] It has been suggested that the long range impact could be significant if our efforts would focus on resolving health disparities instead of focusing our resources mainly on the technology of health care.[64] Woolf et al.[64] suggest that compared to advances in technology, life-saving effects would be 400% greater if our resources were focused on health equity. Thus, focusing on how to address promoting equity and eliminating health care disparity would benefit population health overall.

When planning a public health program or research agenda, various factors should be considered when addressing race and ethnicity. For example, Levy suggests that race and culture impact the doctor-patient relationship, and therefore the outcome of health care. Social and public health care workers should consider the same factors that exist in the doctor-patient relationship and include them when addressing programs and research. These factors may include being aware of prejudice when it exists, recognizing/accepting differences, avoiding stereotyping, being aware of cultural values, understanding culturally unique communication styles, being aware of socioeconomic differences, and understanding how the patient or population may perceive that they are being received.[65] Well-crafted health promotion and education programs and public health research should include these components.

When working with specific populations, we must be aware of variance within the identified group. For example, Borrell[63] describes the wide variety of subcomponents of Hispanics within the United States. Various components of the Hispanic population (e.g., Puerto Ricans, Cubans, Mexicans, etc.) have a distinct ethnicity and set of cultural values. Therefore, our approach should include cultural sensitivity to the specific population being served and avoid stereotyping or trying to provide too general of a solution to a given population (e.g., "all Hispanics"). Another factor is using appropriate data collection methods. For example, the U.S. Census does not provide appropriate identification for Hispanics with data collection, which may impact the direction in which programs or research should be heading.[63] Therefore, having research include the collection of these valuable data would be beneficial.

Disparity between races in the United States is changing but still remains. Information provided in the Health, United States, 2006 database[24] describes the life expectancy, difference in years, and percentage changes in the health care workforce for White vs. Black/African Americans. Based on these data, the discrepancy in overall life expectancy between Blacks and Whites is fairly constant (the gap seems constant) from 1980 to 2004, suggesting that as overall health in the population increases, both subsets increase. However, there is a consistent disparity between both Black and White subpopulations. In order to serve our diverse communities that continue to grow, we need a greater ethnic diversity of health care providers to serve our growing minority populations. There was an increase in the percentage of Black health care providers from 4.9% in 1980 to 6.3% in 1990; however, this was only a 1.4% increase over a 10-year span. More efforts are needed to increase the number of minority health care providers. However, solely increasing the number of health care providers from a certain race in not enough to address this issue. We must also increase the number of providers who are culturally competent and can provide care to a variety of populations.

RELIGION AND SPIRITUALITY

For many people, spirituality and religion are more than a way of living. Spirituality and religion may provide paths to health, alternative therapies to treat disease, or the means of coping with illness.[16,66,67] Because religion and spirituality may be connected with health and quality of life,[66] and are considered important components of culture, we should be aware of their characteristics and be prepared to measure and address their role in a community. Spirituality includes the "aspects of human nature that are not corporeal or tangible."[16] In order for us to recognize or measure spirituality, we must rely on an indirect method of measurement. One way may be to conduct focus groups for various sections of society to identify their belief systems and how these may relate to or play a role in health behaviors and beliefs. Another method may be to use survey instruments or perform observation of people participating in spiritually related activities (e.g., yoga, prayer, meditation, fasting).

Religion is "a system of beliefs unified by acceptance of a divine or superhuman power."[16] To measure religious activities in a community, one may identify the number of active members of a certain religious society (e.g., members of a synagogue, church, mosque, etc.). The amount of activity that the religious society is involved with may also provide insight. For example, if a religious organization has many outreach activities that are involved with health or support services, this would indicate an increased level of involvement. The number of health services or hospitals funded or supported by a religious society is another indicator of the amount of involvement in a community. Other means of identification may include reference to religion in nonreligious activities or communications (e.g., news, sports, education) or the number of religious articles or books published annually in a community.

INDIVIDUAL CHARACTERISTICS

Each community is made up of a set of individuals, each with their own unique set of characteristics (e.g., age, gender/sex, genetics). When addressing an individual's health problems, one must consider the many variables and factors that relate to the health of that particular person. These factors are often quite complex because there are internal and external factors playing a role. However, when we consider how to address the potential health problems of a population, the complexity grows exponentially. In order to address such a complex model, we must have a robust set of tools that can be applied through a structured framework.

In some populations, health indicators are poorer for men than for women, whereas in others it is women who suffer more.[68] We need to better understand the health risk factors that men and women face (e.g., socioeconomic, working conditions, educational level, ability to cope with stress, substance abuse) so that we may better address the cause for these specific groups.

An individual's sex may result in higher risk for some health or disease factors. For example, Feder and Henning[69] remind us that approximately 85% of victims of domestic violence are women, and they are more likely to report abuse than men (22% compared to 7%). In their study of 317 couples where both parties were arrested for violence, they found differences. Women were more likely to use a weapon and men were more likely to have used alcohol and/or drugs.[69] They also found that men were more likely to physically assault or seriously injure their partner and that women were more likely to view their partner as a serious threat. Men were more likely to have demonstrated prior physical violence and threats to kill their partner and/or children than women. Overall, the level of violence was higher for men.[69]

Field and Caetano[70] reviewed aspects associated with partner violence. They found that factors such as history of childhood abuse, parental violence, ethnicity, alcohol abuse, and income level may play some role. They reported that the percentage of male to female or female to male violence differs depending upon the ethnicity of the individual. Domestic violence prevention programs and policies should address such factors in addition to ones discussed earlier, such as access to preventive services, substance abuse, stress management, and financial and psychological support services.

Age is also an individual characteristic and risk factor for health. For example, the older population has an increased risk of disorders and diseases associated with age (e.g., osteoporosis, falls, fractures) and may have a fixed or reduced income, creating an economic barrier to accessing health care. If they take pharmaceuticals, they may be at an increased risk for side effects or adverse events. Age-related mental health issues (e.g., depression, Alzheimer's disease) and reduced social and family support networks are some additional health determinants impacting health in the aged population.

Individual behaviors and practices can intensify or reduce genetically predisposed factors. For example, if a person is known to have a family history of cardiovascular disease, he or she may be more prone to experiencing a myocardial infarction or stroke; however, there may be some modifiable behavior or lifestyle activities that this individual can choose to do in order to reduce the risk.

Increasing physical activity (e.g., walking or bicycling to work instead of taking the car), stopping smoking, maintaining appropriate body weight (e.g., increasing fruits/vegetables intake and decreasing fats), and controlling psychological stress (e.g., meditation, relaxation activities) may assist with reducing the chances of developing cardiovascular disease. Although each individual has a choice, it is their interaction with all other health determinants that will make their decisions feasible. If the individual described above lives in an inner-city area with intense gang activity, the safest way to get to work may not be walking. If all other members of the family smoke tobacco and there is no access to smoking cessation programs, it is unlikely smoking will stop. If there is limited access to fresh produce and the primary source of food is processed or fast food restaurants, food choices are limited. If the individual has no choice but to live in a poor socioeconomic and undereducated community, it may be difficult to escape a high stress environment. Overall, population health must rely not only on the individuals that make up the population, but the other population-based determinants of health that will allow or inhibit these modifiable risk factors.

ADDRESSING POPULATION HEALTH ISSUES

As can be seen in the previous decsriptions and examples, many of the determinants of health overlap or have a direct influence on one another. Poverty can directly relate to education, working conditions, physical environment, and maternal health. Healthy choices and lifestyle may be influenced by physical environment, education, and social/family networks. We cannot address only one health determinant without considering the influence and interaction of the multiple other determinants of a population. All major factors must be considered in order to be effective and to best apply our resources. An integrated and holistic approach to the health of a population may help us to better succeed at achieving a healthy population. If we are to make an impact on population health, we must take the time to learn about the unique characteristics of the population that we are serving. To assist you, we have provided a framework with which to develop your own population health resource packet (**Figure 15-4**).

Competencies for Improving Health on a Population Level

There are obvious inequities in health status associated with a variety of factors, such as poverty, inadequate housing, racism, and a lack of cultural awareness. This suggests that an ecological approach is necessary that recognizes that individuals are integral components of social, political, and economic systems that shape their behaviors and their access to health-sustaining assets.[71] This section presents some skills that one can use to integrate into the public health community to assist in reducing health disparities and improving health in the community.

Change Your Perspective

The first thing you need to do if you are going to be involved in public health on a population level is to change your focus from the ailments of individuals to the prevention of disease or disorder among the population. This is new thinking in U.S. health care, as the Institute of Medicine aptly points out:[72]

> . . . it is necessary to transform national health policy, which traditionally has been grounded in a concern for personal health services and biomedical research that benefits the individual. Approaching health from a population perspective commits the nation to understanding and acting on the full array of factors that affect health.

When taking a population approach to health, one must consider the many determinants of health, such as genetics, behavioral factors, social influences, and environmental factors, which is why we discuss them in this chapter.

Use Available Resources

It is a good idea to consider that if your program is to be widely used, it must be widely accepted across the core health professions and the community you desire to work within.[3] Thus, it is always a good idea to link your program to major initiatives that show the importance of the health issue you wish to address. One authoritative U.S. program is the Healthy People initiative, which is working on goals presented in Healthy People 2010.[73] If you have a great idea, but nobody can see how it fits into the greater public health movement and your idea is not deployable by a variety of health care professionals, then it may be difficult to garner the time, interest, and resources from the key constituents necessary to make your program a success.

Before attempting to start a new community program or other public health venture, it is also important to find out what has already been done because someone may have already done a lot of the footwork, and this will make your life much easier. A good place to start

Each local population and community has different needs and a unique set of characteristics. Chiropractors, as health care providers and participants in social change, should become familiar with the needs of their community and prepare to assist with its unique and specific needs.

Identify the determinants of health for your target population:

- *Socioeconomic status, poverty:* What are the classes and income levels of various subpopulations of your community? What are their specific characteristics?
- *Access to health care resources:* What health care resources are available to the general population? What health care resources are available to the underserved? What are the unique challenges or barriers to accessing health care in each subpopulation? Where can you go to learn more about obstacles to health care access, and what can be done to solve this problem?
- *Physical living environment:* What are the health risks in your community? What subpopulations have different needs and risks in relation to their environment? What can be done to improve the environment for these groups?
- *Work environment, employment:* What are the most common industries and work environments in your area? What health hazards and health risks are specific to these types of employment? What can be done to improve these environments?
- *Education:* What are the percentages of educational levels (eighth grade, high school, college) in your population? How many are literate? What type of communication style or type do you need to learn to serve their needs? What type of health education should be provided to various subpopulations? What can you do to help educate this population about health?
- *Maternal, infant/child health:* What is the infant mortality in various subpopulations? What resources are available to mothers? What resources are available for child development? What can you do to help educate people about maternal, infant, and children's health?
- *Social and family network:* What are the characteristics of social and family networks in the population? What are the characteristic strengths of families in this population?
- *Culture, race, ethnicity:* What are the racial/ethnic/cultural components of this population? What is the percentage of each group? Where can you go to learn more about each group? What type of language, culture, or social customs do you need to learn to communicate and to better serve their needs?
- *Religion and spirituality:* What are the religion and spiritual components in this population? What are the percentages of people in each group? Where can you go to learn more about them? What type of information do you need to learn in order to better communicate with this group?
- *Individual characteristics (age, sex/gender, biology, genetics):* What are the characteristics of your community? What are the percentages of the various age and sex constituencies? Are there specific subgroups that have genetic-related risks (e.g., sickle cell anemia)? What specific health risks are more prevalent in this population? Where can you go to learn more about these health risks? What resources are available to inform people what can be done to reduce their risks and to promote health?
- What other specific or unique needs does this population have that impact health? What information do you need to learn in order to help address these needs?

Being able to answer the above questions will help you better understand your population and to target where your resources will be best directed. Using the information from this chapter as a guide, create a resource packet containing the following information that will address each of the determinants of health:

1. Information specific for patients (handouts, information, websites, hotlines, support groups, etc.).
2. Information for health care providers. Gather information from local, state, or national organizations that provides assistance for specific needs.
3. Create a list of groups, events, activities, agencies of social change, policy development, and other ways that you can become more involved in assisting with these areas.

Figure 15-4 **Develop your own population health resource packet.**

gathering information is the online database PubMed (http://www.pubmed.gov). By reading through research articles you can get useful ideas for what you would like to do and how you would like to organize your own project, gather useful resources for implementing your program, and gather evidence to demonstrate why your program might be necessary.

Maintain Cultural Competence

The United States certainly is a melting pot, when one considers that more than 300 different languages are spoken by U.S. residents and more than 30 million U.S. residents speak a language other than English when they are at home.[3] Although such diversity is laudable, it can present some challenges in health care. It is well documented that certain ethnic groups and races are burdened with higher rates of disease, morbidity, and mortality, and tend to receive a lower quality of health care than nonminorities.[74] Cultural competence is a concept that attempts to address such disparities.[75] Cultural and linguistic competence is an important part of achieving the goals of Healthy People 2010 if we are to increase quality and years of healthy life, eliminate health disparities, and address one of the leading health indicators-access to health care. There are many barriers to health care, and various authors view these barriers in different ways. Some authors look at cultural differences, language barriers, and discrimination,[74] whereas others look at the health care system and identify organizational, structural, and clinical barriers.[75]

Anderson and colleagues[74] provide a nice definition of the components of cultural competency:

> *Culture* refers to integrated patterns of human behavior that include the language, thoughts, communications, actions, customs, beliefs, values, and institutions of racial, ethnic, religious, or social groups. *Competence* implies having the capacity to function effectively as an individual and an organization within the context of the cultural beliefs, behaviors, and needs presented by consumers and their communities.

In clinical practice on a daily basis you can aid in reducing health disparities by creating and maintaining a culturally competent clinic system that can prevail over language and psychosocial barriers that may preclude appropriate diagnosis, treatment, and follow-up.[74] This demonstrates that you can effectively provide for your clients. Anderson and co-workers[74] suggest that a culturally competent setting includes the following five characteristics:

- A culturally diverse staff that reflects the community served
- Providers or translators who speak the clients' language
- Training for providers about the culture and language of the people they serve
- Signage and instructional literature in the clients' language and consistent with their cultural norms
- Culturally specific health care settings

Some people may think that cultural competence means we try to understand our patients and then shoehorn them into the Western medicine paradigm that makes up the U.S. health care system. This may not be very effective. Through ongoing population health research, we find that cultural competence also includes science-based research into the relationships among culture, behavior, and health outcomes. As stated by one researcher, "Culture is not a barrier to good health, but an integral part of it." [76] If we are to be truly culturally competent, in addition to being sensitive in our interactions with patients, we need to be avid consumers of the literature that studies the cultures we serve, including their understandings of health, their behaviors, foods, family structures, spiritual communities, and more.[76]

Collaborate with Your Community

When working with your community, it is important to engage community members in the process. For example, if you develop a health promotion activity in isolation, there is a very good chance that the implementation of the program will fail due to a lack of community interest and support. It has been identified that community collaborations empower participants, strengthen social engagement, establish trust, and ensure accountability.[72] There are several types of community collaborations, including coalitions, partnerships, community advisory boards, consumers' rights/advocacy groups, and nonprofit organizations. You can become involved in many of these collaborations through general membership, participation on committees, or serving on boards of such organizations. Chiropractors have served on local public health boards and emergency response agencies, and have developed community partnerships.

If you wish to participate in a community collaboration, it is important to gather a basic idea of how they work. Most collaborations begin to develop before a particular agenda is planned, thereby obtaining membership or involvement that is representative of the community for which the project is intended. Fawcett and colleagues[77]

have identified a framework for collaborative public health action that encompasses some quality improvement strategies to enhance the potential effectiveness of a collaboration, and this is a great initial resource. Another excellent resource that describes how collaborations work and provides very practical information for participating in a collaborative enterprise is *Coalitions and Partnerships in Community Health* by Butterfoss.[78]

Influencing Community Policy

Education pertaining to health policy has not been part of most clinical health professional curricula. However, if one desires to effect change in a public manner, then one must have a basic understanding of policies that affect health care practice and the health of patients and communities, processes through which policies are developed, and consider participating in policy making.[3] If you have a desire to participate in community policy making, a good way to get started is by attending meetings where policy is discussed in order to observe the process. Once you are comfortable with how things work, you might consider volunteering to become part of a policy committee or task force where you can work with others and become more at ease with the various practices and politics involved. Some organizations offer training in policy making through seminars and conferences, and these may be excellent opportunities for you to obtain more knowledge and skills. For those who have a strong desire to effect change in this area or to pursue additional career options, it may be necessary to obtain further education, such as a master's degree.

CONCLUSION

When studying or participating in population or community health, the unit of study is a large group. When working in this area, the determinants of health for both individuals and communities must be considered, and one must be aware of health disparities that exist in the population. Further, cultural differences should be appreciated and not ignored. Only by viewing our world through this "big picture" will we find the means necessary to change modern society's vision of health care from the curing of individuals' illnesses to the provision of illness prevention services to populations.

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CHAPTER
16

CHAPTER OUTLINE

Principles of Health Care Systems with Considerations for Chiropractic

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Most broadly, a health care system can be defined by its principal goal to improve population health through the delivery of various services and programs. The full spectrum of health care services and programs includes a range of health promotion, prevention, and intervention activities. Health promotion or prevention might include activities designed to encourage healthy lifestyle behaviors such as exercise or discourage unhealthy habits such as tobacco use, or measures to prevent transmission of communicable disease. Health care interventions may be designed to restore some measure of health or functioning lost through illness or injury. Interventions may be intended to stop or slow down irreversible declines in health or functioning associated with certain health conditions, or even to slow down the declines of normal aging processes. Certain interventions may be principally designed to reduce or relieve pain, perhaps temporarily, such as during the course of acute or subacute episodic conditions, or even to improve pain-coping skills such as through a longer term chronic pain management plan. And finally, end-stage palliative interventions may be provided to relieve suffering or even to help persons with terminal conditions to prepare for death, such as in the case of end-of-life hospice care.

These various health improvement activities, as well as others, may be delivered through collective actions of groups such as health care programs provided by multidisciplinary teams of health care providers or governmental health agencies. Or, health care may be provided by individual health care service providers. A health care activity may be specifically provided to benefit an individual, as in the case of a typical doctor's visit, or provided to benefit a group of people, such as promoting healthy environments. The cost for delivering a particular service within a health care system may be paid directly by the individuals using the service, or the cost may be shared by a group of persons such as through a health insurance plan, or the cost may even be spread across the larger society such as in the case of tax-supported measures to ensure clean water.

As you can see from the preceding overview, health improvement actions delivered as health care services or programs within a health care system generally can be described along three main dimensions: the *type of activity* (e.g., prevention vs. intervention actions), *who benefits* from the activity, and *who bears the cost* of the activity. A given health improvement action may be designed to *benefit* an individual, a larger collective group, or even society as a whole. As well, the *cost* for providing a health improvement activity may be borne by an individual or a larger collective or society.

The cultural, social, and economic context of health and health care may vary considerably across populations, nations, and ideologies. These individual and collective perspectives, which reflect underlying cultural and social values as well as the economic realities of finite resources, largely determine how health care systems are created, organized, and shaped over time, and how the various health improvement actions are prioritized or fit within the larger context of an overarching health care delivery system.

For instance, in certain countries, health care is provided to the citizenry directly through the government, as a public service. Great Britain's National Health Service (NHS) provides publicly funded health care to all British residents. In addition to NHS, there is also a small private sector health services market and health insurance market in the United Kingdom, which allows consumers the option of purchasing health services or health insurance outside of the public NHS system. Countries such as Canada and Sweden have national-level health insurance established by the government as a public service, coupled with a largely private health services market.[1] So, as you can see by just the few examples offered here, there are many different ways in which health care systems might be organized, and many different approaches, both private and public, to provide or pay for health care.

In this chapter I will consider fundamental principles and concepts of health care delivery systems, largely using examples drawn from the U.S. health care system to illustrate or clarify key points. Where possible, this discussion of health care systems and health care policy will cite examples and concepts of particular relevance to chiropractic health care providers.

HEALTH SERVICES AND HEALTH INSURANCE, PUBLIC AND PRIVATE

National or regional economies can be subdivided into general goods and service sectors that contain common or related industries and markets, such as the health care industry and market sector, housing sector, education, transportation, or entertainment. Within the health care market sector, there are two important and distinct markets that operate in tandem: the health services market and the health insurance market. Within these two key markets there are also numerous submarkets; for instance, within health services, you could consider the market for hospital inpatient services as being essentially different and separate from the market for primary care services. But the following discussion will stay focused on just the two most obviously distinct markets in health care, health services and health insurance, which are presented in the typology of **Table 16-1**.

The first paragraph of this chapter reviewed a broad range of various health-related activities through which goods or services are "produced' or "consumed" within a health services market, such as a doctor's office visit or a product to help people to quit smoking. A given health service or product might be provided either publicly by the government, through the private sector, or through some coordinated arrangement between both public and private sectors.

Health insurance is a bit different, in that the "product" is essentially a means to share the risk of the cost of illness or injury across a larger collective group. In the private sector, an individual purchases insurance through an insurer, which offers financial protection to offset the costs to an individual in the case of statistically rare events such as illness or injury. When insurance is provided through the public sector, which is also sometimes called social insurance, the government acts as the insurer.

The United States has been described as having a "mixed system,"[1] including both public-sector and private-sector elements in its health services market and health insurance market (see Table 16-1). One way of explaining how this mixed U.S. health care system came into being is that it has generally evolved from a history of health care policies and programs arising from interpretation of what constitutes an appropriate role for government within the context of the free-market economy of the United States.

The U.S. economy is fundamentally founded on a price system in which most wages and prices are determined in the market, not set by government.[2] Uncommon exceptions have occurred, such as during the extreme economic conditions of the early 1970s that led to passage of the Economic Stabilization Act, which imposed temporary price controls on all sectors of the U.S. economy including the health care sector. Such rare exceptions aside, U.S. government intervention in its economic sectors is generally low, and especially so in the health

Table 16-1 Examples of Historical Roles of Government in the Health Services and Health Insurance Markets in the United States

	Health Services Market	Health Insurance Market
Public sector (government directly provides health services or "social insurance")	Indian Health Service (IHS), Military (MHS) and Veterans (VA) Health Systems	Medicare, Medicaid, CHAMPVA, TRICARE/CHAMPUS
Private sector (government regulates industry to protect consumers and promote competition)	Licensure and accreditation, antitrust (e.g., *Wilk et al. v. AMA*)	Minimum reserve requirements, HMO Act, Health Insurance Portability and Accountability Act (HIPAA)

for Table 16-1, please insert a space in between the top row of text and the bottom row of text? I.e. the top row of text "Public sector(govt . . . . "social insurance") cannot be clearly distinguished from the bottom row of text "Private sector(govt . . . competition)". Similarly, in the second column, difficult to discern top row ("IHS,MHS,VA Health Systems") from the bottom row ("Licensure . . . . AMA)"). The third column has a good spacer between top and bottom row, so easy to see that these are two separate rows in third column. Please reformat the table just slightly to make it also clear in the first two columns, the separation between the top row of text and the bottom row of text?

services and health insurance markets when compared to the health care systems of other nations.

One appropriate role of government in health care, as interpreted by U.S. policymakers, is to correct the inherent inequities of the free-market price system (i.e., to redistribute resources to vulnerable populations such as the poor, elderly, or disabled). The protection of these vulnerable population groups from the "harsh realities" of the health care market system has largely been through the Medicare and Medicaid programs, which originated as essentially social insurance programs in the United States during the 1960s.

As a practical consideration, the U.S. government has also assumed a role in directly providing health care services to its active military force through the Military Health System (MHS), and to retired, disabled, and otherwise eligible veterans of previous military service through the health care system of the Veterans Health Administration (VHA). The MHS and VHA were initially established as entirely self-contained health care delivery systems, with all services provided "in-house." More recently, the TRICARE/CHAMPUS and CHAMPVA managed care programs have expanded the health care options available for the military and veteran populations, by reimbursing members for their health care purchased through the private-sector health services market.

The Indian Health Service (IHS) is another example of a health care system established by the U.S. government to directly provide health care services specifically to the indigenous population of Native Americans in the United States. The IHS has also undergone recent transformation toward greater self-determination, in that many of the health care programs and facilities that had formerly been directly controlled by the federal government have increasingly been turned over to be administered locally under direct tribal authority and funded by tribal revenues.

Aside from directly providing health services and health insurance to limited populations in the public sector, the predominant historical role of the government in the U.S. health care system can be described as one of safeguarding the free-market price system of the private sector by protecting consumers and by promoting competition in the health care marketplace. Described in the next two paragraphs, and also listed in Table 16-1, are historical examples of U.S. governmental interventions that support free-market functioning by regulating the private-sector health care system: licensure and accreditation, enforcement of antitrust law and minimum reserve requirements, the HMO Act, and the Health Insurance Portability and Accountability Act (HIPAA).

In a private-sector market, consumers choose between comparable goods or services on the basis of the perceived "value" to the consumer. A purchased good or service may have value for a consumer for any number of reasons, most typically price and quality. The "quality" of a health care service may not be readily apparent to a typical consumer, because health care is highly technical in nature; therefore, a role for government in regulating health care is to protect consumers by ensuring a minimal level of quality, or safety, by enforcing standards for professional licensure for health care practitioners and accreditation of health care facilities. Chiropractic licensure in all 50 U.S. states requires an earned Doctor of

Chiropractic (DC) degree from an accredited chiropractic college; examination in basic science, clinical science, and clinical competency by the National Board of Chiropractic Examiners; and licensure testing by the specific state board under which the chiropractor practices. Similarly, a role for government in the private-sector health insurance market is to protect consumers, for instance by requiring that insurers hold minimum reserves in order to meet their promised obligations to their insured populations.[3] The Health Insurance Portability and Accountability Act (HIPAA) of 1996 protects health insurance coverage for workers when they change or lose their jobs and limits the restrictions that an insurer can place on benefits for pre-existing conditions.

In addition to protecting consumers, another role for government in the private sector is in promoting competition. The HMO Act of 1973 promoted competition in the health insurance market by mandating that employers who offered insurance to their employees must also include an option for a managed care prepaid health plan, or health maintenance organization (HMO).[4] An example of antitrust enforcement in the health services market, with which many chiropractors are familiar, is the *Wilk et al. v. AMA* court case, in which the American Medical Association (AMA) was found guilty of violating federal antitrust law by engaging in practices designed to restrict cooperation between MDs and chiropractors in order to eliminate the profession of chiropractic as a competitor in the U.S. health care system.[5]

Recapped briefly, in public-sector health care, the government directly delivers health services or directly acts as the insurer in a "social insurance" program. A government role in regulating the private-sector health care delivery system in the United States has historically centered on protecting consumers and promoting competition. Current and future health care reform aims to further improve the functioning of both public-sector and private-sector health care delivery systems, through both consumer-oriented and market competition approaches. Consumer-oriented government regulation in health care serves to *protect* consumers through fundamental safety mandates. Additionally, much current health reform aims to also *empower* consumers to be more knowledgeable about health care and better able to discern the comparative value of their health care choices.

CONSUMER PROTECTION AND CONSUMER EMPOWERMENT IN HEALTH CARE

Figures 16-1 and **16-2** provide good example of advances in consumer protection and consumer empowerment in the health services market, representing how the concept of "quality" in health care has evolved over time. As presented earlier in this chapter and in Figure 16-1, professional licensure and accreditation serves to ensure a minimal level of quality, or safety, in health care. The assumption underlying this early model of quality assurance is that highly credentialed health care providers (both practitioners and facilities) are expected to render high quality care through optimal processes that will, in turn, produce good patient outcomes.

More recent developments in health care reform build further upon these fundamental consumer protection assurances, and now increasingly also emphasize the importance of better understanding the consumer's perception of "value" in health care, and the importance of incorporating consumer preferences and consumer choice into health care decisions.[6,7] This idea is portrayed in Figure 16-2, wherein the fundamental assurances of quality and safety through credentialing are a foundation upon which "evidence-based" care is built. Evidence-based care draws from a body of scientific evidence, from outcomes research, and similar sources to provide better information to both clinicians and patients about the potential benefits of various clinical options for their care, thereby supporting "informed choice" in the health services market. Examples of patient outcomes that typically may be assessed in routine chiropractic practice include measures of pain, measures of function or disability, length of time before the patient returns-to-work following injury or other condition, or general health-related quality-of-life indicators of patients' physical, psychological, emotional, and social well-being.[8,9]

Evidence-based care empowers consumers in the health services market by promoting a more active shared role for consumers in health care decision making. A growing emphasis on consumer empowerment in current health care reform initiatives can also be witnessed in the evolving scholarship of health law and health care ethics. For instance, the ethical principle of

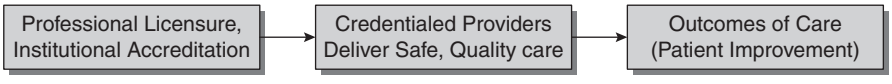

Figure 16-1 Quality assurance for consumer protection in health care.

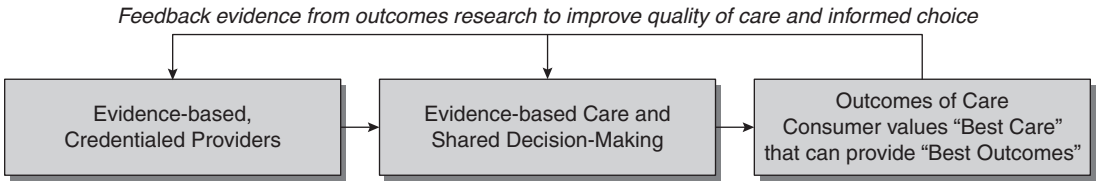

Figure 16-2 Quality assurance for consumer empowerment: evidence-based care and informed consumer choice.

autonomy can be described as respect for an individual's self-rule and independence from controlling influences, enabling individuals to make reasoned informed choices, and respect for confidentiality.[10] In the context of scientific research, this and other ethical principles are essential components of an individual's granting informed consent to participate as a subject of scientific research. Within the context of health care delivery in the health services market, recent discussions have begun to explore the potential for, and implications of, replacing "informed consent" with "informed patient choice" as a standard of clinical practice.[11,12] The ongoing research and discourse on this topic suggests that shared decision making and informed patient choice in health care honors the values and preferences of the patient and further improves overall patient satisfaction as an explicit measurable outcome of health care.

The current era of electronic data presents a timely and opportune focus for current health reform to further advance consumer protection, consumer empowerment, and health care efficiency through information technology and Internet access. Updating and extending HIPAA in 2003, HIPAA Title II provisions set civil and criminal penalties for numerous offenses relating to health care, created several programs to prevent fraud and abuse in the health care system, and created standards for the use and dissemination of health care information to protect the security and privacy of health data and improve the efficiency and effectiveness of the health care system. The electronic health record (EHR) is increasingly being adopted as the standard for managing patient information within and between health care providers and payers. In addition, individual patients are availing themselves of options for securely managing their own electronic health records and data, for instance through Internet data management tools such as Google Health.

Similar consumer empowerment initiatives in health reform aim to improve the information literacy of consumers and to make complex health care information more "transparent" and accessible to the typical consumer. Value-based purchasing of health services and health insurance is much more likely to occur when consumers can more clearly and accurately assess just what it is they are paying for, and how much it costs.

The cost of health care is obviously an important consideration for both the individual consumer and for third-party payers such as private insurers, employers, and government. The direct "out-of-pocket" cost for the typical individual consumer's health care in the United States may include some combination of various costs for both health insurance coverage and their health services not covered by insurance. One direct out-of-pocket cost of health insurance paid by the consumer is the premium to obtain insurance coverage for themselves or their families. Or consumers may pay a share of the insurance premium for employer-sponsored or government-sponsored plans. When an insured consumer uses health services covered by their insurance plan, they will also share in the cost of those health services by paying deductibles and copayments. For example, a given insurance policy may require that a consumer pay for the first $100 of his or her medical expenses each year before the insurance will begin paying for expenses above that first $100 (i.e., this plan has a $100 deductible). The insurance plan may also require that the consumer share the cost for covered health services; for instance, the consumer may be required to copay a part of the cost for a doctor's office visit, or provide a fixed payment toward the cost of prescription medications. Individual consumers may also pay directly out of pocket for health care goods and services not covered by their insurance, or if they are uninsured.

Spanning the health insurance and health services markets, insurers in the public and private sectors, also called third-party payers, can influence the price of health services by exerting their collective bargaining power to negotiate a payment structure for purchasing health services. Such collectively set payment structures may be applied, or enforced, for both insurers as third-party payers and consumers as individual purchasers of health services. In addition to exerting collective

purchasing power in the health services market, third-party payers such as employers, insurers, or the government are able to use sophisticated methods and analyses to inform their health services purchasing decisions. For instance, insurers may collect and analyze data from their beneficiaries who use chiropractic health services, in order to make informed judgments about the cost of chiropractic care, outcomes of care such as the length of time before the patient returns to work, patient satisfaction with care, or preferences for chiropractic relative to other forms of care.[13–18]

For the typical individual consumer with health insurance, a large part of their ability to exercise value-based judgments for their health care purchasing decisions actually occurs at the point of purchase in selecting their insurance plan. The Consumer Assessment of Health Plans Study (CAHPS-I), first launched in 1995, was a cooperative effort of a number of federal agencies (e.g., Centers for Medicare and Medicaid Services [CMS], National Institute for Disability and Rehabilitation Research, Agency for Healthcare Research and Quality [AHRQ], among others) and private-sector research organizations to collect information about consumers' perceptions of and satisfaction with the quality of their health insurance plans. Over time, the CAHPS-II program (same acronym, but now renamed the Consumer Assessment of Healthcare Providers and Systems) expanded beyond its original focus to also assess consumers' total experiences with health care, including both health insurance plans and a range of health care services. Chiropractic-specific survey items were developed to supplement CAHPS, though not formally incorporated into CAHPS-I.[19,20] CAHPS and other similar programmatic initiatives that are designed to inform and empower consumers undergo continual development with better scientific methodologies, in order to improve the relevance and user-friendliness of such information for the typical consumer of health care.[20] The AHRQ-sponsored consumer-oriented website (http://www. ahrq.gov/consumer) offers content that describes quality measures such as accreditation, consumer ratings, evidence-based clinical practice guidelines, and clinical performance measures to assist consumers in making health care decisions that are right for them, such as choosing a health plan that includes coverage of chiropractic, acupuncture, or physical therapy services, for example.

Health reform initiatives that advance a more participative role for individual consumers in shared decision making in the clinical and financial aspects of their health care are central to consumer empowerment in the health services and health insurance markets. As a patient in the health care system, a more knowledgeable informed consumer is better equipped to partner with their clinical care provider to assess the potential benefits, potential risks, and best choice for their specific individual health care needs within the options available to them. An informed consumer in the health insurance market is better able to purchase or choose a health insurance plan that best meets the specific needs of themselves and their families, from among the options of health plans available to them.

Consumer protection and empowerment interventions by government may align with a related role for government, that of ensuring equitable opportunities for its citizenry by preventing discrimination against members or segments of its population. For example, government-supported initiatives to document the extent to which the U.S. population is uninsured or underinsured allow better understanding of possible disparities in access to health insurance, in order to identify feasible and sustainable solutions for achieving parity in access to health insurance coverage for such groups.[21–24]

An equally compelling health policy mandate is to ensure equitable and adequate access to health services. Depending on practice location or outreach efforts, chiropractic providers individually or collectively may serve as a vital point of access to health care for certain populations with otherwise compromised access to health services or health insurance.[25–32] Another interesting and somewhat complex example is in the application of HIPAA law to prevent potential discrimination in the case of "wellness programs" offered by employers or their insurers. For instance, an employer may offer financial incentives to encourage healthy behaviors, such as a discount on health insurance costs for nonsmokers. However, HIPAA law requires that all workers covered under the same employer-sponsored health plan must pay the same premium (i.e., the group plan may not charge higher premiums to individuals due to health status, medical history, genetic information, claims experience, receipt of care, or evidence of disability). Addiction to nicotine can be considered a medical condition, so smokers must be offered a reasonable alternative way to earn the same discount offered to nonsmokers, such as participating in a smoking-cessation program.[33]

An empowered consumer is better informed to understand the health care options available to them, to exercise value-based judgments about those options, to express their preferences as a consumer, to share the responsibility for making clinical and financial decisions in their health care, and to participate more fully as a consumer in making health care choices that are right for them.

CONCLUSION

Health care systems may vary considerably from country to country in terms of how they are organized across private and public sectors, the manner in which various health services are delivered, and in how those health services are financed or purchased. Fundamental differences among nations in their economic, cultural, and social ideologies may be reflected in how national health care issues are prioritized or organized relative to other national concerns, or perhaps even in how health and social concerns are defined for the purpose of allocating resources. For instance, one nation's perspective may view residential care for the aged and handicapped as a fundamental social service outside of its health care system, whereas long-term nursing care of elderly or disabled populations in other nations is classified as an expenditure within its health care sector.[34] An important common element of health care systems is the notion of the value of health care, which serves as the basis of analyses and cross-national comparisons that focus attention on fiscally sound, socially responsible, evidence-based health policies to develop sustainable health care systems and attain the goal of improving population health and well-being.[35]

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CHAPTER
17

Public Health: A Personal Responsibility?

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CHAPTER OUTLINE

There is a discrepancy between potential and actual life expectancy. The genetically determined potential maximum life span appears to be close to 122 years.[1] For those born in the United States in the year 2000, the estimated average life expectancy was 67.2 years, for Canadians it was 70 years, and for those born in Japan it was 76.3 years.[2] A global ranking of life expectancy places Japan 1st and Canada 17th. Despite channeling vast amounts of money into health care, the United States ranked 28th. In 2006, the United States spent an estimated $2.1 trillion, or 16% of the gross domestic product (GDP), on health care.[3] Federal spending on Medicare and Medicaid alone is 5% of GDP, and this is predicted to rise to 20% by 2050 given current trends. In fact, "The long term fiscal balance of the United States will be determined primarily by the future rate of growth of health care costs."[4] The same may be said of other nations. Clearly, the time has come for health authorities to review their approach to the management of disease and those factors that influence mortality and

morbidity. A good starting point is the realization that, of the five domains that influence premature death, health care has a comparatively small impact. Indeed, the proportional contributions to premature death are behavioral choices (40%), genetic predisposition (30%), social circumstances (15%), health care (10%), and environmental exposure (5%).[5]

TARGETING INTERVENTION

Although health care receives by far the greatest share of resources and attention, personal behavior and genetic composition are the major determinants of health status.

The Genetic Environment

The U.S. Department of Health and Human Services provides a tool on the Internet for families to formulate a flow chart to identify those diseases to which a family demonstrates genetic susceptibility.[6] Advances in molecular biology are increasingly making the notion of genetic engineering a feasible option. Although the idea of gene replacement no longer resides in the realm of science fiction, phenotype modification by changing the cellular environment provides an alternative more readily accessible to all members of society. For example, by genotyping all type II diabetics and supplementing with 400 IU of vitamin E those with a haptoglobin 2 allele, it appears that the risk of adverse cardiovascular events can be reduced.[7] This genetic intervention does not prevent a susceptible individual from developing diabetes, but it does reduce susceptibility to developing diabetes-associated complications. Although disease prevention through genotyping to detect disease susceptibility in apparently healthy persons may emerge as standard public health practice, the success of this measure ultimately depends on the individual's willingness to embrace behavior change.

The Social Environment

It would appear that behavioral choices not only dominate susceptibility to disease, but also offer the greatest opportunity for health promotion. To substantially improve road accident statistics, environmental factors such as improved roads and safer motor vehicles need to be accompanied by drivers wearing safety belts, not driving when under the influence of drugs or alcohol, and obeying traffic laws. Similarly, introduction of fluoridated water increases the strength of tooth enamel, but tooth decay remains strongly influenced by dental hygiene. Immunization provides protection against a number of micro-organisms, but behavioral choices may determine pathogens exposure.

The Individual in Society

Although genetic, social, and environmental engineering are all viable change alternatives, encouraging individuals to make prudent, informed behavioral choices deserves to loom large in any public health agenda for improving health and reducing premature deaths. The crucial challenge facing the health care system in the 21st century is to motivate an informed population to make health-promoting choices.

FROM BELIEFS TO BEHAVIOR

The 2005 National Health Interview Survey of the civilian, non-institutionalized adult population found that 62% of adults 18 years or over reported excellent or very good health.[8] Self-perceptions of health are an important predictor of mortality. One study reported that older adults who rated their health as "bad/poor" and "fair" were more than twice as likely to die within 3 to 3.5 years following the initial survey than those who perceived their health as "excellent."[9] It is generally accepted that perceived health status is predictive of changes in the individual's functional ability, health care use, and mortality.[10]

Perceptions

Perceptions influence choices; however, perceptions are not necessarily accurate. Smokers provide a prime example of how individuals can discount the increased personal risk they face from their behavioral choices. In 44 developed countries in 1990, tobacco was responsible for 24% of all male deaths and 7% of all female deaths, rising to 17% in women in the United States.[11] The average loss of life for all cigarette smokers was about 8 years; this loss doubled for those whose deaths were directly attributable to tobacco. A survey of current smokers found only 29% believed they had a higher-than-average risk of myocardial infarction.[12] Even half of those smokers with angina failed to acknowledge they may run a greater than average risk of myocardial infarction. When only heavy smokers (i.e., those smoking in excess of 40 cigarettes daily) were analyzed, the prevalence of perceived increased risk did increase, but only marginally, to 39% for a heart attack. In reality, smoking increases the risk of

coronary artery disease 1.7–3.0 times, stroke by 1.7–8.0 times, and sudden death by 1.4–10.0 times.[13] Smokers also underestimate their risk of cancer—less than half of current smokers perceived themselves as being at increased risk when in reality their risk is more than double that of a nonsmoker. Smoking also increases morbidity. Compared to nonsmokers, in current smokers the relative risk of a hip fracture is similar at age 50, 17% greater at 60 years, 41% higher at 70, 71% higher at 80, and 108% greater at 90 years.[14]

Another study reported that the majority of smokers who described themselves as "occasional" and "social" smokers believed that they had "already quit" or had no intention of quitting smoking. They did not view their smoking behavior as presenting a high risk.[15] In reality, they not only may have been placing themselves at risk, but also may have been jeopardizing the health of others. Endothelial dysfunction alters coronary flow velocity reserve after 30 minutes of passive smoking.[16] The risk of a heart attack increases as does fibrinogen, a risk marker for infarction. It has been postulated that passive smoking augments ischemic heart disease mortality statistics by 6 and heart attacks by 10 each day in Germany.[17]

Ignorance or Denial?

Somewhat surprisingly, one explanation proffered for smokers' apparent lack of concern regarding their tobacco habit is ignorance. One international study suggested that smokers are not fully informed about the risks of smoking and suggested that warnings communicating the health risks of smoking should be more graphic, larger, and more comprehensive in content.[18] If ignorance is indeed a problem, then some other interventions must have contributed to the marked decline in tobacco-related health risks.

The prevalence of smoking in the United States declined among men from 57% in 1955 to 23% in 2005 and among women from 34% in 1965 to 18% in 2005.[19,20] The mortality rate attributable to smoking also declined in the United States by about 35% between 1987 and 2002.[21] Whereas in 1987 smoking-attributable causes accounted for 24% of all deaths for men 35 years or older, by 2002 this had declined to 17%. In women the smoking-attributable mortality rates declined from 12% to 9% during this period. Despite alleged "ignorance" of the tobacco-related health risks, the disease impact of tobacco is declining. It appears that lifestyle changes may not be based solely on the health-related information.

An Eclectic Approach

Information campaigns combined with external pressure appear to offer a more effective approach in altering population norms. Where the promise of improved health fails as an incentive to quit, increased taxes on cigarettes may provide an economic imperative. Where once smokers' rights were sacrosanct, nonsmokers' rights now reign supreme. Laws, regulations, and litigation have been used to achieve smoke-free public places. Indeed, recognition of smokers' community obligations represents a fundamental shift and is a pillar underlying meaningful health reform.

CHANGING BEHAVIOR

Health is a social and not just an individual matter, so an eclectic approach combining diverse approaches to behavior change would seem to hold the key to wellness reform. A number of the most important public health victories in the United States in the past century—ranging from declining lead exposure through improvements in the workplace to motor vehicle safety—were the result of new legislation, heightened regulatory enforcement, litigation, or a combination of the three.[22] Such intervention does, however, create tensions among the freedoms of choice, speech, and contract. Furthermore, legal constraints, although useful in advancing health care, provide at best a crude behavior control mechanism. Before the population as a whole can be expected to make healthy lifestyle choices, it is necessary to change the outlook of individuals. It is, for example, unlikely that legislative changes alone can combat the galloping obesity problem besetting many developed countries. A lifestyle characterized by prudent eating and exercise is more likely to be achieved by changing the cognitive framework of individuals.

The Obesity Problem

Currently, there are around 1 billion overweight and obese people in the world, with obesity affecting some 18 million children under the age of 5.[23] In the United States, overweight and obesity escalated from 13% in the 1960s to 32% in 2004. In the 2003 to 2004 period, two out of three adults were overweight or obese while 16% of children and adolescents were overweight and a further 34% were at risk of becoming overweight.[24] Even more alarming is the projection that, given current trends, 75% of all adults living in the United States will be overweight or obese by 2015; 41% will be obese.

Initiatives to halt this trend are urgently needed. Incentives could range from selective imposition of taxes on energy-dense foods to subsidization of nutrient-dense products, from restriction on advertising to detailed food labeling.

The Advertising Option

In the United States, restriction on advertising comes under the auspices of the Federal Trade Commission (FTC); however, its mandate is limited to regulating advertising only of it is perceived to be deceptive.

Studies suggest that advertising achieves its intended effects. Empirical studies suggest the product preferences and eating habits of U.S. children are shaped by the approximately 29,000 candy, cereal, and fast food advertisements to which they are exposed annually.[22] Reducing commercials from 12 to 10.5 minutes per hour on weekends appears not to have had a substantial impact. Other countries have used different measures. Sweden bans the use of cartoon characters to promote foods to children under 12 years of age; Australia bans food advertisements targeted at children under 14 years old.

Food Labeling

In contrast to advertising, control of food labeling falls under the auspices of the Food and Drug Administration (FDA), which specifically prescribes what must be displayed on food labels. In general, the energy content and macronutrient, vitamin, mineral, water, and additive content are listed in order of quantity. More recently, Canadian as well as U.S. authorities, in addition to the more routine requirement of labeling total and saturated fat, have also required that the content of trans-fatty acids be listed.[25,26] Trans-fatty acids, which carry a cardiovascular risk similar to that of saturated fats, may be found in substantial quantities in some manufactured foods. By requiring that trans-fatty acid content be listed, Canadian authorities provide consumers with useful information and potentially create market pressure on manufacturers to review the extent to which their current production processes affect macronutrients.

Food Manufacturers: Responding to the Challenge

Food manufacturers are not oblivious to the looming health problems, and are cognizant of the critical scrutiny being given both to individuals' eating habits and the content of manufactured foods. A number of food manufacturers are actively exploring options for product modification. It has been estimated that about one third of all new products introduced into the United States focus on health,[27] and many of them focus on heart health. In the past year alone, 200 heart-healthy products have been introduced. The top three product categories for heart-healthy products are dairy, beverages, and baked goods. Further growth in cardiovascular product positioning has been seen in processed fish, meat, and egg products and breakfast cereals.

Manufacturers' interest in producing health-promoting foods is not necessarily altruistic. Increased consumer interest in and awareness of the health benefits of flavonoids may well account for the increase in sales in recent years of flavonoid-rich foods in the United Kingdom, where between 2005 and 2007 the sales of blueberries increased by 135%, nondairy soy drinks by 50%, and green tea by 45%.[27]

In addition to labeling providing information on energy and nutrient content, food labels can include health claims. In the United States, the FDA permits foods containing at least 51% whole grains by weight that are low in total fat, saturated fat, and cholesterol to carry a health claim linking them to a reduced risk of heart disease and certain cancers.[28] Consuming at least one serving of whole grain cereal a day could reduce a man's risk of heart failure by 30%. Food labels can also receive a stamp of approval from credible government-approved organizations. In Australia, foods that meet the dietary guidelines for promoting cardiac wellness can apply for and receive a stamp of approval from the Heart Foundation in the form of a healthy heart checkmark.[29]

Multifaceted Intervention

While legislative encouragement continues to grow, manufacturing and marketing of health-promoting foods can create a macro-environment in which more health-promoting alternatives become available on the supermarket shelf. In the meantime, accurate labeling of processed and fast foods can create the micro-environment required for prudent dietary selections. However, only informed, motivated consumers are likely to benefit from these initiatives.

Despite the best efforts of legislators and conscientious food manufacturers, the decisive safeguard against obesity rests with the consumer. Although consumer education can provide the knowledge necessary to make prudent choices, it is only personal motivation to

not overindulge in energy-dense temptations that limits calorie consumption. Although external forces can make a substantial contribution to health promotion, personal responsibility is ultimately the essential ingredient required to fuel a wellness revolution. A multifaceted approach to behavior change is needed.

THE IMPACT OF LIFESTYLE CHOICES

The key lifestyle variables that can enhance life expectancy are intimately linked to personal choice. Cardiovascular disease and cancer are the leading causes of death and disability in developed countries[2]; however, over 80% of cases of coronary heart disease and type II diabetes and 33% of cases of cancer could be prevented by changes in lifestyle factors.[30] Choices as simple as living in a smoke- or tobacco-free environment, performing 30 minutes of physical activity a day, and eating a diet that emphasizes fruits, vegetables, and low-fat dairy products have a major impact on life expectancy.

Behavioral risk factors such as smoking, poor diet, physical inactivity, and excessive drinking are linked to the leading causes of death in the United States.[31] Analysis of the 2003 Behavioral Risk Factor Surveillance System for Americans ages 18 to 24 years of age found more than three quarters (78.4%) of respondents consumed fewer than five fruits and vegetables per day, 43.2% reported insufficient or no physical activity, 28.9% were current smokers, and 30.1% reported binge drinking.[32] Dietary factors have been associated with ischemic heart disease, stroke, diabetes, and cancers of the colon, breast, and prostate. The impact of primary prevention on the overall incidence of cancer through quitting tobacco smoking is 18%, through dietary change is 4.2%, and through alcohol avoidance is 2.2%.[33] It has been estimated that dietary habits may correlate with around 60% of cancers in women and 40% of cancers in men.[33]

Regular, frequent physical activity increases life expectancy.[34] Physical inactivity has been associated with increased risk for heart disease, diabetes, colon cancer, osteoporosis, and even dementia. In fact, exercise capacity and energy expenditure from adult recreational activity are stronger predictors of cardiovascular diseases than established risk factors such as smoking, hypertension, obesity, and diabetes.[35] Despite this, the 2008 National Health Interview Survey found that 62% of adult Americans never participated in any type of vigorous leisure-time physical activity.[8] Although provision of walking and cycling trails, parks, and public swimming pools may provide facilities for recreational exercise, it is ultimately personal motivation that determines the health benefit of wellness-enhancing community facilities.

MOTIVATION

In both disease and wellness care, client behavior strongly influences the outcome. In the case of the former, the patient's discomfort acts as an inducement to adhere to the treatment regimen. In the case of wellness care, the client's evaluation of the costs versus the benefits of changing habits provides the stimulus to change. Like disease care, wellness care involves identifying wellness goals, choosing from intervention options, monitoring progress, and evaluating the intervention.[36] Whereas in disease care patients often perceive a direct link between their chiropractic adjustment and symptom relief, in wellness care the association between current behavioral choices and health status is less clear. Also, whereas in disease care the benefits of intervention are often rapidly enjoyed, in wellness care the benefits are usually delayed. Instead of physical validation for complying with a treatment regimen, in wellness care cognitive commitment to lessening the risk of a potential problem is required. The traditional clinical model of practitioner dominance is not suited to wellness care. Indeed, the clinical model, in which the clinician is largely responsible for accomplishing symptom relief, is counterproductive in wellness care.

The Clinical Consultation

Wellness care requires that the patient take increased personal responsibility for their well-being. Motivating patients and clients to change habitual behaviors requires a change from the clinical model of practitioner dominance to a patient-centered model of care.

A relational patient–practitioner consultation is the hallmark of any clinical encounter that seeks to motivate behavior change. The relational model can take two distinct forms—guidance cooperation and mutual participation.[37] Both of these models require active patient participation and are conducive to the practice of self-care; the difference lies in the extent of patient responsibility. In the relational mode, the reciprocal relationship that develops between patient and practitioner ranges from one in which the practitioner provides guidance and the patient selectively cooperates, to one in which the patient assumes substantial personal responsibility

for his or her health care. Patients or clients with an internal locus of control who are more self-directed do particularly well in an atmosphere of mutual participation; those with an external locus of control often do better when offered more guidance.[38]

Another consultation model that suits wellness care was developed by the Emanuels.[39] They describe informative, interpretative, and deliberative modes of interaction. In the informative mode, the practitioner provides the patient with relevant factual information, and the patient, using personal values, selects the preferred intervention. In the interpretative mode, the practitioner elucidates the patient's values and wants, and then helps with the selection of an intervention. In the deliberative mode, the practitioner provides factual information and clarifies the types of values embodied in each option. There is less patient participation than in the interpretative variant because the practitioner also explains why certain health-related options are more worthy and should be aspired toward. In all three modes, the emphasis is on patient self-care, with wellness being the desired outcome.

The Wellness Consultation

In all instances, it is imperative that the wellness plan be negotiated to achieve the necessary commitment to implement the behavioral changes required for health promotion.

Negotiating Change

Motivation to change a habit requires the patient to become acutely aware of the risks of not changing, to actively explore the benefits of changing, and to have the opportunity to select their preferred intervention from a variety of options. Negotiation is the strategy used to ensure the final wellness plan reflects the patient's aims and values and is not the brain child of the practitioner.

One of the characteristics of successful wellness negotiations is the creation of dissonance. Collaboration enables the patient to own their wellness program and increases the likelihood of adherence, but it is awareness of inconsistency between current behavior and life goals that serves as a stimulus for change. The creation of dissonance in the wellness consultation is achieved by behavioral cost–benefit analysis. Creating dissonance requires that the patient become sensitized to the risks of their current lifestyle choices and knowledgeable about the benefits to be gained by embracing change. Compilation of a behavioral consequences balance sheet, in which the positive and negative consequences of a given behavior are listed and contrasted, is a useful tool.

The creation of dissonance is fundamental to Kopel and Arkowitz's approach to behavior change, which is based on attribution and an individual's self-perception.[40] Attribution theory suggests that the perception and causal attribution of physiological arousal is an important determinant of emotional behavior, and that self-attribution of behavior change increases the likelihood that changes will be maintained. Self-perception theory proposes that inferences arising from self-observation of one's own overt behaviors may affect subsequent behavior, attitudes, and beliefs. When these theories are combined, an individual's perception of their behavior, situational circumstances, and physiological states may be anticipated to influence the initiation and retention of any behavioral change.[40]

Motivational Interviewing

Motivational interviewing is the strategy used to create dissonance about noncompliant behavior. The goal of motivational interviewing is to explore a patient's ambivalence in such a way that the patient is more likely to choose to change his or her behavior in the desired direction.[41] Motivation to change is evoked in the patient; it cannot be imposed by the practitioner. It is the practitioner's task to expect and recognize ambivalence, and help the patient examine and overcome such hesitation. Skillful motivational interviewers roll with client resistance, express empathy, avoid arguments, develop discrepancy, and support self-efficacy.[42] The reasons for resistance must be identified and addressed if behavior is to change. Resistance alerts the practitioner to the need to gather more information. It may be encountered when a client does not believe the proposed changes are necessary, finds the proposed intervention unacceptable, or feels unable to make the necessary changes. Social cognitive theory posits a multifaceted causal structure in which self-efficacy beliefs operate together with goals, outcome expectations, and perceived environmental impediments and facilitators in the regulation of behavioral choices[43]

Outcome expectancies are the belief that a given behavior will lead to a particular outcome; efficacy expectancies are the belief that one can successfully execute the necessary behavior to achieve the desired outcome.[44] Although overcoming dissonance may modify outcome expectations, only providing patients with

Table 17-1 Motivational Interviewing

Obstacle to Change	Motivational Interview Technique
Health is a low priority.	Enhance awareness of personal health risk and the advantages of wellness.
Poorly informed, lacks and skills.	Provide relevant knowledge resources and skills.
Denies personal risks.	Assist in self-assessment of personal risk.
Lacks commitment.	Provide ownership of their wellness plan.

the knowledge and skills to bring about the desirable behaviors will achieve the desired change. Self-efficacy is fundamental to personal change, affecting whether people contemplate changing a habit, are self-motivated to persist with changes, and recover from setbacks or relapses to maintain the changed habit.[43] **Table 17-1** outlines how motivational interviewing can be used to overcome the obstacles to change.

The goal of motivational interviewing is to achieve behavioral change by helping patients explore and resolve ambivalence.[45] Motivational interviewing uses an evidence-based counseling approach. Counseling is an exchange of information so that clear treatment goals and expectations are explored.

The patient-centered style of interaction favored for chiropractic clinical practice lends itself to the wellness consultation in which the helping relationship is transformed from that of patient–practitioner to that of the less formal client and health professional. Furthermore, although motivational interviewing in the chiropractic clinic is likely to increase consultation time, forays into wellness care need not all be time consuming. Even short advice messages of up to 60 seconds are helpful.[46]

MAKING PRUDENT CHOICES

It is becoming increasingly evident that the ailing health care system is unable to unilaterally cope with the escalating costs of caring for an aging population. Individuals are going to need to take increased personal responsibility for their own well-being. Fortunately, individual behavioral changes can achieve far-reaching health benefits.

The Enormous Health Impact of a Single Lifestyle Change

Health can be enhanced by minor lifestyle changes. Converting from a sedentary to an active lifestyle, for example, provides far-reaching health benefits.

Physical activity is any bodily movement that results from musculoskeletal activity and expends energy. Exercise is a planned, structured subset of physical activity that usually involves repetitive bodily movement. The aim of exercise is to improve health or fitness. Health gains can be achieved with relatively low volumes of exercise. A cumulative total of 30–50 minutes of aerobic exercise performed on 3 to 5 days a week accompanied by one set of resistance exercises targeting the major muscle groups twice weekly produces significant health benefits.[47] At a minimum, 30 minutes at moderate intensity on 5 days of the week appears necessary; both the total of 150 minutes per week and the five sessions appear important.

The Impact on Longevity

One of the health benefits attributed to exercise is a reduced risk of dying.[48] An inverse linear dose–response relationship between volume of physical activity and all-cause mortality has been clearly demonstrated.[49] What is less clear is the contribution made by exercise intensity, duration, and frequency. Moderate activity, such as brisk walking for 30 to 60 minutes a day most days of the week, has been shown to be associated with a significantly reduced risk of cardiovascular disease with respect to both incidence and mortality.[50] This study suggested physical activity need not be vigorous to benefit health; another found that brisk walking for 20 minutes, 3 days a week failed to alter cardiovascular disease risk factors in previously sedentary adults.[51] Energy expenditure, which is influenced by exercise intensity and duration, may hold the key. Physical activity that results in energy expenditure of approximately 4200 kJ weekly appears to be associated with substantial benefit.[50]

The Cardiovascular Benefit

Although the minimal effective exercise dose required for cardiovascular health remains undetermined, some information is available on the impact of exercise on lipids and blood pressure. Hyperlipidemia and hypertension are two of the major modifiable risk factors for ischemic heart disease, so such data are clinically useful.

With respect to blood lipids, it appears that, regardless of fitness level, optimizing the blood lipid profile requires walking in bouts that last longer than 20 minutes.[52] Another study suggested that, compared with sedentary persons, it takes walking at least 7 miles a week to get a statistically significance increase in high-density lipoprotein (HDL) cholesterol.[53] Training programs that use 1200 to 2200 kcal weekly also effectively increase HDL cholesterol and lower triglycerides.[54]

Compared to sedentary persons, exercising for as little as 30 minutes weekly has a beneficial effect on blood pressure; however, maximum benefit for systolic blood pressure is achieved after 60–90 minutes of exercise.[55]

Weight loss also is recognized as one of the lifestyle modifications that effectively lowers blood pressure.[56] Overweight and obesity are established risk factors for both cardiovascular disease and diabetes, and exercise is acknowledged as a useful intervention for reducing body fat, especially intra-abdominal fat.[57]

Abdominal obesity is a feature of the metabolic syndrome, which is characterized by insulin resistance and is determined by genetic factors, obesity, and lack of physical activity. In addition to hyperglycemia, the pathophysiological features of this syndrome are dyslipidemia, hypertension, and a prothrombotic and proinflammatory state. The metabolic syndrome provides an ideal scenario for myocardial infarction because it predisposes persons with it to atherosclerosis and coagulation.

The benefits of an active lifestyle are independent of body weight, however.[58] Indeed, good aerobic fitness is associated with a better cardiovascular risk factor profile, regardless of the level of abdominal obesity.[59]

Other Benefits

In addition to a lower cardiovascular and diabetes risk,[60] persons who are physically active also have a reduced risk of certain cancers such as colorectal cancer and probably breast cancer.[61] Activity also benefits the musculoskeletal system. For maximum skeletal benefit, exercise should be brief, dynamic, exceed a threshold of intensity and strain frequency, and impose an unusual loading pattern on the bones.[62] Furthermore, although greater loads and fewer repetitions result in greater gains in bone mass, exercises that introduce stress to the skeleton through joint-reaction forces such as weight lifting or rowing are potentially more beneficial because they reduce the risk for falls.[63]

Exercise should be encouraged in all age groups regardless of age. Indeed, exercise enhances physical function in the elderly and increases feelings of well-being.[64] Enhanced well-being may be related to improved sleep. Exercise that consisted primarily of low-impact aerobics or brisk walking for 30 to 40 minutes four times a week at 60% to 75% of resting heart rate reduced sleep latency by about 15 minutes and increased sleep duration by about 45 minutes per night in elderly patients with sleep difficulties.[65] The psychological benefit of exercise may also be attributable to exercise being a natural antidepressant.[66] An added benefit is the potential for exercise to reduce the risk for physical comorbidities prevalent in depressed patients.

The Physiological Impact of a Single Dietary Choice

Exercise is not the only intervention that influences an array of physiological processes. Diet also plays a key role. For example, garlic has the potential to be used in the prevention and treatment of myocardial infarction.[67] Meta-analysis of randomized, double-blind, placebo-controlled trials concluded that garlic is superior to placebo in reducing total cholesterol levels.[68] However, because the size of the effect was modest, these authors questioned the usefulness of garlic for treating hypercholesterolemia, a concern supported by a number of rigorously designed controlled studies.[69] Hypercholesterolemia, however, is only one factor contributing to atherosclerosis.

Atheroma formation results, not from native cholesterol but from oxidized cholesterol. Garlic is an antioxidant. Hypertension is a major modifiable risk factor for ischemic heart disease. Garlic lowers blood pressure. A heart attack follows coronary occlusion, and garlic inhibits platelet aggregation and enhances fibrinolysis. Although garlic may not warrant consideration as an antihyperlipidemic agent, it nonetheless influences a range of processes involved in infarction. Garlic's impact on any one of these processes may be small, but when taken in combination it would appear that garlic warrants consideration in a heart-healthy diet. The ability of garlic to influence a number of processes forms the basis of its potential to achieve clinically meaningful outcomes. Clinically relevant outcomes may best be achieved by combining various lifestyle interventions.

The Summative Effect of Combining Interventions

A number of lifestyle choices combine to determine the risk of osteoporosis. The best protection against an osteoporotic fracture in later life is high peak bone mass. Each person's degree of bone mass is regulated by the interaction between genetic factors and environmental influences, particularly nutrition and exercise. Bone mass and strength vary according to the loads to which the bone is exposed. These loads come from the muscles rather than from body weight. Dynamic exercises that impose greater loads with fewer repetitions are most conducive to bone health. If bones are to adapt optimally to the forces to which they are exposed, however, an adequate diet is also necessary.

Windows of Opportunity

Although lifestyle choices have an impact at all stages of life, there are certain periods where prudent choices are critical. Girls accrue half and boys a quarter of their total bone mass during puberty. An active lifestyle and calcium-rich diet in the presence of adequate vitamin D has long been considered essential during adolescence. More recently it has become apparent that omega-3 fatty acids may also contribute to attaining a high peak bone mass in adolescence.[70] Women with low milk intake and/or a high omega-6:omega-3 ratio during childhood and adolescence have less bone mass in adulthood and are at greater risk of fracture.[71,72]

Bone remodeling is an ongoing process, and bone mass is the result of the interaction between the processes of osteoclastic bone resorption and osteoblastic bone formation. During childhood the balance is in favor of bone formation; in adulthood the pendulum swings to favor bone resorption. The balance becomes particularly unfavorable in estrogen-deprived women. In postmenopausal women, lifestyle choices that correlate with a decreased risk of fractures include a dynamic exercise regimen and a diet rich in soy products, fruits, vegetables, and tea complemented by a calcium and vitamin D supplement enriched with boron, magnesium, and vitamin K.[73,74] Other protective lifestyle choices are being a nonsmoker and limiting alcohol intake to no more than 20 grams daily.[75,76]

TAKING A BROAD-BASED APPROACH

Although individual changes are beneficial, for optimal health a comprehensive approach is necessary. Furthermore, small changes can have significant outcomes—in both a positive and negative direction. This is particularly true when a number of small changes act in concert.

Conflicting Behaviors

The ability of competing healthy and unhealthy habits to neutralize health benefits or indeed to fail to combat health risk is well demonstrated by the "American paradox."[77] In the adult U.S. population, the prevalence of overweight people rose from 25.4% between 1976 and 1980 to 33.3% between 1988 and 1991, a 31% increase. During the same period, average total daily calorie intake tended to decrease, with fat intake decreasing by 11% and consumption of low-calorie products increasing from 19% to 76%. Despite eating more wisely, the U.S. population got fatter. An explanation for the diverging trends was a dramatic decrease in total physical activity–related energy expenditure. Body weight is ultimately determined by the balance between energy intake and energy output, and minor lifestyle changes can have substantial repercussions on health.

Small Changes, Big Repercussions

Apparently trivial changes, when repeated on a regular basis, can have substantial health impacts.

Small Excesses, Big Penalties

Omitting either 100 g (3.5 ounces) of chocolate, 1.5 pieces of cheesecake, or 5 teaspoons of butter from the diet each day can result in a weekly weight loss of up to 0.5 kg (1 pound). Conversely, to gain 5 kg (11 pounds) a year all that is needed is an increased weekly intake of one of the following: 20 g (3/4 ounce) of chocolate, 1/3 pieces of cheesecake, 21 g (3/4 ounce) of french fries, or 1 teaspoon of butter. To reduce daily energy intake by about 1000 kJ, you can replace 10 french fries with a boiled potato, or replace a package of potato chips with 1 piece of fruit, or replace 1 pint of full-fat milk with low-fat milk, or replace soft drinks with diet soft drinks.

The alternate option to decreasing energy intake is to increase energy expenditure. Jogging for 24 minutes or running fast for 17 minutes uses the energy provided by a single can of beer. Other ways to utilize the extra 630 kJ from a can of beer are 45 minutes of brisk walking,

cycling 5 miles in 30 minutes, or swimming laps for 20 minutes.

Minor Achievements, Large Benefits

Health benefits are clinically relevant with even a modest weight loss of 5–10% of starting weight.[78] Analysis of the literature found that weight loss of 1 kg (2.2 pounds) can decrease serum cholesterol by 1%, triglycerides by 1.9%, and fasting plasma glucose by 3.6 mg/dL.[57] Meta-analysis of 70 studies reported that for every kilogram decrease in body weight, subjects at a stabilized, reduced weight increased their HDL cholesterol by 0.009 mmol/L; subjects actively losing weight achieved a 0.007-mmol/L increase.[79] Most randomized controlled studies have shown that weight loss of 3–9% is associated with a significant reduction in systolic and diastolic blood pressure of roughly 3 mm Hg in overweight people.[80] Another study confirmed a net weight reduction of just over 5 kg (11 pounds) by means of energy restriction with or without increased physical activity reduced systolic blood pressure by 4.44 mm Hg and diastolic blood pressure by 3.57 mm Hg.[81] Conversely, systolic blood pressure increases 1 mm Hg for every 1.7 increase in body mass index (BMI) in men and for every 1.25 increase in women.[82]

The Impact of Minor Changes on Population Statistics

At the population level, a reduction in blood pressure levels can have a substantial impact on morbidity and mortality statistics. A reduction of 4–5 mm Hg in systolic and 2–3 mm Hg in diastolic blood pressure would be expected to reduce the risk of stroke by about 20%, coronary heart disease by 10%, and all-cause mortality by 8%.[83] Another study calculated that by achieving the target of 140 mm Hg, there would be a reduction of 28–44% in stroke and 20–35% in ischemic heart disease, depending on the person's age. This would prevent approximately 21,400 stroke deaths and 41,400 ischemic heart disease deaths each year—and these translate to approximately 42,800 strokes and 82,800 incidents of ischemic heart disease prevented, making a total of 125,600 events prevented per year in the United Kingdom alone.[84]

CONCLUSION

The need to care for our planet and for ourselves appears to be reaching a crisis point. The major challenge of the 21st century would appear to be to provide each individual with the knowledge, skills, and motivation to take increased personal responsibility for the well-being of their micro- and macro-environments.

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CHAPTER
18

Integration of Chiropractic into the Public Health System in the New Millennium

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CHAPTER OUTLINE

MOVING FORWARD IN THE NEW MILLENNIUM

> Chiropractic still maintains some vestiges of an alternative health care profession in image, attitude, and practice. The profession has not resolved questions of professional and social identity, and it has not come to a consensus on the implications of integration into mainstream health care delivery systems and processes. In today's dynamic health care milieu, chiropractic stands at the crossroads of mainstream and alternative medicine. Its future role will probably be determined by its commitment to interdisciplinary cooperation and science-based practice.[1]

This 2002 summary of the position of chiropractic in the health care system is still applicable. In the early years of the new millennium, annual use of chiropractic by the general public did not increase, or even may have slightly decreased, from the 11% reported for 1997[2] to

the 8–12% reported for 2002–2003.[3,4] This chapter will describe how integration with the public health system may contribute to resolving the issue of professional identity as well as facilitate a profession-wide commitment to "interdisciplinary cooperation and science-based practice."

In 1996, the Association of Chiropractic Colleges (ACC) published a position paper defining chiropractic as "a health care discipline which emphasizes the inherent recuperative power of the body to heal itself without the use of drugs or surgery. The practice of chiropractic focuses on the relationship between structure (primarily the spine) and function (as coordinated by the nervous system) and how that relationship affects the preservation and restoration of health."[5] There is obviously considerable congruence between this definition and that of *public health*: "a society's efforts to protect, promote and restore health."[6]

Thus, integrating chiropractic into the realm of public health appears to be an appropriate avenue for approaching integration. Whether chiropractors practice as back specialists, musculoskeletal portals of entry, primary care physicians, or wellness practitioners, health promotion and prevention are essential components of their practice, just as they are of public health practice.

Furthermore, contributing to local and national public health initiatives not only serves the public welfare, but also serves to integrate the chiropractic profession into the health care mainstream and increase general awareness of it as a member of the health care community. As stated in *The Future of Chiropractic Revisited: 2005–2015*, ". . . better public outreach is needed to raise the profile of chiropractic to the public."[7] A concerted effort by the profession to integrate with public health initiatives would go far toward communicating to the public that chiropractic emphasizes health, wellness, and prevention, rather than exclusively providing pain relief.

How should the profession approach this avenue of integration? Certainly, many chiropractors have been involved in the public health arena, as has been described in an earlier chapter of this book. However, these involvements have usually been accomplished through individual interest and effort. The profession has not yet developed a systematic roadmap for integration.

HEALTHY PEOPLE 2010: ROADMAP FOR INTEGRATION

It is not necessary to invent such a roadmap; one already exists: the Healthy People initiative. Healthy People 2010 and the forthcoming Healthy People 2020 form the cornerstone of evidence-based prevention and health promotion activities in the United States.[8] The Office of Disease Prevention and Health Promotion of the U.S. Department of Health and Human Services (HHS) coordinates this effort, which has been developed and implemented by a broad-based array of government, public, and private agencies and organizations. Over 400 organizations are partners in this initiative. Healthy People 2010 provides a blueprint to effectively track and address the most important health care needs of all Americans. It is important to note that this initiative focuses on disease prevention and health promotion rather than disease treatment, and that all its recommendations are completely grounded in the best available scientific evidence, yet developed through a consensus of experts and public stakeholders.[8,9]

Healthy People 2010 is the current generation of an initiative that began in 1979 with the Surgeon General's report, *Healthy People*. Immediately following the 1979 report, in 1980, was *Promoting Health/Preventing Disease: Objectives for the Nation*. In 1990, *Healthy People 2000: National Health Promotion and Disease Prevention Objectives* appeared. Midway through the decade after the publication of Healthy People 2010, midcourse reports appeared, documenting progress toward the objectives. In 2008–2009, public meetings began gathering input for the first phase of Healthy People 2020 and the specific objectives, with strategies for achieving them, commence in 2010. Thus, the Healthy People initiative is an ongoing process, changing in response to the nation's health needs and moving forward through the combined efforts of concerned citizens, health professionals, and public and private agencies and organizations.[8]

The primary goals of Healthy People 2010 are to increase quality and years of healthy life and to eliminate health disparities. Under these two broad, overarching goals, there are 28 focus areas with 467 specific, measurable objectives to guide national health promotion activities in the next 10 years. **Table 18-1** lists the 28 focus areas, emphasizing the areas most immediately relevant to chiropractic clinical practice, based on responses to surveys of chiropractic practitioners.[10–12] **Table 18-2** gives selected examples of objectives in those specific focus areas, illustrating some of the more relevant objectives in terms of chiropractic practice. These are the focus areas and objectives that will be used to outline a possible roadmap for chiropractic integration into this national initiative and thereby into the public health arena.

Health Indicators

Leading health indicators are an important part of measuring Healthy People's objectives. Health indicators were

Table 18-1 Healthy People 2010 Focus Areas*

Number	Focus Area
1.	**Access to Quality Health Services**
2.	**Arthritis, Osteoporosis, and Chronic Back Conditions**
3.	Cancer
4.	Chronic Kidney Disease
5.	Diabetes
6.	Disability and Secondary Conditions
7.	Educational and Community-Based Programs
8.	Environmental Health
9.	Family Planning
10.	Food Safety
11.	Health Communication
12.	**Heart Disease and Stroke**
13.	HIV
14.	Immunization and Infectious Diseases
15.	**Injury and Violence Prevention**
16.	Maternal, Infant, and Child Health
17.	Medical Product Safety
18.	Mental Health and Mental Disorders
19.	**Nutrition and Overweight**
20.	**Occupational Safety and Health**
21.	Oral Health
22.	**Physical Activity and Fitness**
23.	Public Health Infrastructure
24.	Respiratory Diseases
25.	Sexually Transmitted Diseases
26.	Substance Abuse
27.	**Tobacco Use**
28.	Vision and Hearing

*Focus areas most relevant to customary chiropractic practice are shown in **bold**.

Source: U.S. Department of Health and Human Services. Healthy People 2010. 2nd ed. Understanding and Improving Health and Objectives for Improving Health. 2 vols. Washington, DC: U.S. Government Printing Office, November 2000.

selected based on their impact on the health of the public, as well as the large amount of data available about each one. They are listed in **Table 18-3**. Because of their tremendous significance to all health initiatives, each indicator is described briefly in the following sections, emphasizing their particular relevance to usual chiropractic practice. Five of the 10 health indicators are particularly relevant to chiropractic practice and will be discussed in more detail later in the chapter. **Figure 18-1** graphically illustrates chiropractors' opinion on the application of the health indicators to chiropractic practice, as assessed by a national survey of chiropractors on clinical preventive services.[11]

Access to Health Care

Indicators for assessing access to quality health care include having health insurance, having a regular primary care provider, and using clinical preventive services, particularly early prenatal care for pregnant women. Ways chiropractors can contribute to clinical preventive services delivery are discussed under "Focus Area 1: Access to Quality Health Services" later in this chapter.

Physical Activity

Regular physical activity maintains physical and psychological health and helps prevent many diseases, disability, and premature death. According to the Centers for Disease Control and Prevention (CDC), in 2003, 46% of adults met the recommendations for physical activity (at least 30 minutes of moderate activity per day at least 5 days per week) and 16% took part in no leisure-time physical activity at all.[13]

Overweight and Obesity

Increased body mass index (BMI) contributes to higher death rates. Health care and lost work time costs associated with obesity were estimated in 1995 at $99 billion.[14] Moreover, spending for the medical care of obesity in the United States has been estimated to account for 9.1% of the total annual U.S. medical expenditures in 1998 or $92.6 billion in 2002 dollars.[15] During the time Healthy People 2010 was being developed (late 1980s–early 1990s), 11% of children and teens were overweight or obese and 23% of adults were obese. By 2004, 16% of children and 34% of adults were obese.[8–13,16]

Tobacco Use

Tobacco use annually results in the death of over 443,000 persons in the United States.[17] This is more than the combined total from AIDS, alcohol, cocaine, heroin, homicide, suicide, motor vehicle crashes, and fires. Due to effective state programs on tobacco control, adult smoking prevalence in the United States declined from 29% to 19% from 1985 to 2003.[18]

Injury and Violence

Injuries, which are either intentional (caused by violence) or unintentional (accidents), were the fifth leading cause of death in 2002.[19] However, injury rates declined 41% from 1970 to 2002, largely due to national, state, and private injury prevention programs, such as mandatory seat belt use.

Table 18-2 Selected Examples of Objectives in Focus Areas Most Relevant to Chiropractic Clinical Practice

Focus Area	Objective Number	Specific Objective Example
1. Access to Quality Health Services	1–3	Increase proportion of persons appropriately counseled about health behaviors.
2. Arthritis, Osteoporosis, and Chronic Back Conditions	2–11	Reduce activity limitation due to chronic back conditions.
12. Heart Disease and Stroke	12–11	Increase the proportion of adults with high blood pressure who are taking action (for example, losing weight, increasing physical activity, or reducing sodium intake) to help control their blood pressure.
15. Injury and Violence Prevention	15–19	Increase use of safety belts.
	15–20	Increase use of child restraints.
	15–21	Increase proportion of motorcyclists using helmets.
	15–23	Increase use of helmets by bicyclists.
	15–27	Reduce deaths from falls.
	15–28	Reduce hip fractures among older adults.
19. Nutrition and Overweight	19–1	Increase the proportion of adults who are at a healthy weight.
	19–5	Increase the proportion of persons aged 2 years and older who consume at least two daily servings of fruit.
	19–6	Increase the proportion of persons aged 2 years and older who consume at least three daily servings of vegetables, with at least one-third being dark green or orange vegetables.
20. Occupational Safety and Health	20–2	Reduce work-related injuries resulting in medical treatment, lost time from work, or restricted work activity.
	20–3	Reduce the rate of injury and illness cases involving days away from work due to overexertion or repetitive motion.
22. Physical Fitness and Activity	22–1	Reduce the proportion of adults who engage in no leisure-time physical activity.
	22–4	Increase the proportion of adults who perform physical activities that enhance and maintain muscular strength and endurance.
	22–5	Increase the proportion of adults who perform physical activities that enhance and maintain flexibility.
27. Tobacco Use	27–5	Increase smoking cessation attempts by adult smokers.

Source: U.S. Department of Health and Human Services. *Healthy People 2010*. 2nd ed. Washington, DC: U.S. Government Printing Office; 2000.

The following five health indicators are not as closely related to usual chiropractic practice, but they are important for all chiropractors to be familiar with so they can appropriately counsel or refer patients who have issues in these areas.

Substance Abuse

Use of alcohol and illegal drugs contributes to intentional and unintentional injuries, particularly motor vehicle crashes, as well as to human immunodeficiency virus (HIV) infection. Alcohol abuse also contributes to a number of diseases. Costs associated with alcohol abuse were estimated at $184.6 billion in 1998,[20] and from illegal drug use $180.8 billion in 2002.[21] The National Institute on Drug Abuse of the National Institutes of Health has a website with information sheets for professionals and the public at http://www.drugabuse.gov/drugpages.html.

Responsible Sexual Behavior

Negative health consequences of unprotected sexual behaviors are unintended pregnancy and sexually transmitted disease (STD), including HIV infection. Either abstinence or correct and consistent use of condoms are recommended as preventive measures. Chiropractors could refer patients whose history and/or presentation suggest that they are at risk back to their primary care physician or to local public health, Planned Parenthood, or women's health clinics for information and/or counseling.

Table 18-3 Leading Health Indicators from Healthy People 2010*

Physical activity
Overweight and obesity
Tobacco use
Substance abuse
Responsible sexual behavior
Mental health
Injury and violence
Environmental quality
Immunization
Access to health care

*Indicators most relevant to customary chiropractic practice are shown in **bold.**

Source: U.S. Department of Health and Human Services. Healthy People 2010. 2nd ed. Understanding and Improving Health and Objectives for Improving Health. 2 vols. Washington, DC: U.S. Government Printing Office, November 2000.

Mental Health

The annual prevalence of mental illness is estimated at 20% of the U.S. population, with depression the most commonly experienced disorder. Depression is a leading cause of disability and contributes to more than 60% of suicides annually.[22] The U.S. Preventive Services Task Force recommends asking two questions of all adult patients to screen for depression: "Over the past 2 weeks, have you felt down, depressed, or hopeless?" and "Over the past 2 weeks, have you felt little interest or pleasure in doing things?"[23] Patients who respond positively to these questions should receive more in-depth assessment for depression, and be referred as appropriate.

Depression frequently accompanies chronic pain syndromes, so chiropractors will often see depressed patients and should establish contacts with local mental health resources. The Substance Abuse and Mental Health Services Administration (SAMHSA) sponsors the Center for Mental Health Services, which can provide local contacts throughout the United States; its website is http://mentalhealth.samhsa.gov/databases/.

Environmental Quality

Air pollution remains a serious health issue in the United States, contributing to approximately 50,000 deaths and resulting in estimated annual health-related costs of $40 billion to $50 billion.[24] The most important indicators of air quality are ozone for outdoor air and second-hand tobacco smoke for indoor air. The CDC has a large number of printable and downloadable resources about indoor air pollution available for both health professionals and their patients at http://www.nlm.nih.gov/medlineplus/indoorairpollution.html.

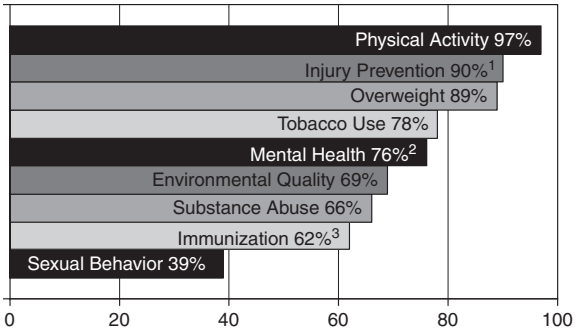

Figure 18-1 Proportion of chiropractors who agree that chiropractors should obtain information from patients to identify those at risk.

Source: Hawk C, Long CR, Perillo M, Boulanger KT. A survey of U.S. chiropractors on clinical prevention services. *J Manipulative Physiol Ther*. 2005;27:287–298.

[1]indicates % respondents who agreed chiropractors should provide information on this topic to patients in appropriate risk category.

[2]indicates % respondents who agreed that chiropractors should obtain information on depression/anxiety

[3]indicates % respondents who agreed that chiropractors should provide information on immunization both "pro" and "con"

Immunization

Immunizations help control the transmission of infectious diseases within communities; formerly common diseases such as smallpox and poliomyelitis have been virtually eradicated in the United States.

A segment of the chiropractic profession has strongly opposed immunizations, based primarily on nonscientific reasoning and, at best, anecdotal evidence.[25] This vocal minority has caused many health care providers and public health professionals to tend not to trust chiropractors in general, particularly for treating children.[26] Because chiropractic education varies in its coverage of immunization issues, practicing chiropractors could benefit from having sources of authoritative evidence on immunizations readily available, in addition to having collaborative relationships with public health professionals who could provide them or their patients with in-depth information.[18,25] The Chiropractic Health Care section of the American Public Health Association (APHA) offers the profession an immunization information website with links to many high-quality information sources which may be accessed at http://www.apha-chc.org.; The CDC's immunization website is http://www.cdc.gov/vaccines/.

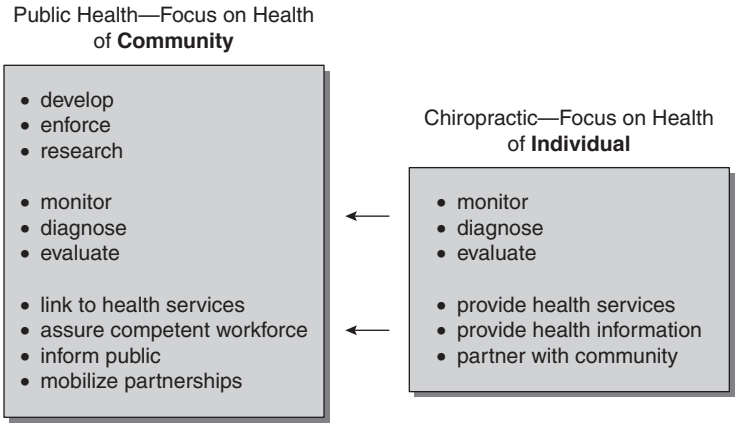

Figure 18-2 Relationship between public health and chiropractic practice.

Joining the Movement Toward "Healthy People in Healthy Communities"

According to Healthy People 2010, "Developing strategies and action plans to address one or more of these indicators can have a profound effect on increasing the quality of life and the years of healthy life and on eliminating health disparities—creating *healthy people in healthy communities*."[8] The chiropractic profession has not, in the past, systematically joined with other health professionals, nor has its institutions and organizations formally joined with other public and private organizations to address the Healthy People objectives. However, as described in earlier chapters, chiropractors and chiropractic organizations and institutions are moving toward such collaborations.[27] The Chiropractic Health Care Section of the APHA, in particular, has done a great deal to foster collaboration with the health care mainstream to promote the health of the public.[28]

Healthy People 2010 provides a well-defined and broad-based framework through which chiropractic can integrate into public health activities, either nationally, such as through APHA, or locally, because state and local health departments all participate in activities designed to meet the Healthy People objectives.

THE INTERFACE BETWEEN CHIROPRACTIC PRACTICE AND PUBLIC HEALTH

Like other health care professions, chiropractic is concerned primarily with the health of the individual, whereas public health is concerned with the health of the community. However, perhaps due to the chiropractic profession's development in relative isolation from the rest of the health care community, chiropractors have not traditionally viewed public health as relevant to their profession.[29] In reality, all health care providers' work has a certain amount of overlap with public health's core functions. **Figure 18-2** summarizes these functions in relationship to chiropractic. The essential public health functions are:[30,31]

- *Assessment:* Public health agencies are responsible for monitoring the community's health status, disease incidence, health hazards, and other health-related events in order to diagnose health problems at the community level. This is usually referred to as surveillance. Public health agencies also are responsible for evaluating health services provided to the population, in terms of effectiveness and accessibility to all populations served.
- *Policy:* Policy development and enforcement are essential to ensure that environmental and other issues are consistently and fairly addressed in the community. Research to identify new ways to address health problems is also included as part of this function.
- *Assurance of services:* Public health agencies not only link individuals with needed personal health services, but also provide some services, especially relating to health promotion and prevention. Public health is also concerned with assuring the public of having access to competent health care providers, providing information to the public about health, and mobilizing community partnerships to ensure that community health issues are effectively addressed.

The interface between chiropractic private practice and public health is primarily in the area of assurance of services, although private practitioners can also contribute to assessment through state and national surveillance systems (see Figure 18-2). Chiropractors have traditionally provided information to patients on health promotion and prevention, because these concepts are integral to chiropractic. It is important for the profession's future integration into the health care system that chiropractors not only continue to do this, but also find ways to do it in collaboration with public health agencies. As stated in Healthy People 2010, "Because individual and community health are virtually inseparable, both the individual and the community need to do their parts to increase life expectancy and improve quality of life."[8] Chiropractors can contribute to public health by continuing to provide prevention and health promotion services at the individual level, but they can also become advocates for various health issues by joining with organizations and agencies to effect change at the community or even national level.[32] The CDC has an excellent resource available on prevention practiced at the level of the community, the *Guide to Community Preventive Services*.[33]

USING A WELLNESS MODEL FOR INTEGRATION OF CHIROPRACTIC INTO PUBLIC HEALTH

As mentioned previously, chiropractic has not yet come to consensus on its public identity. Even without such consensus, however, the increasing emphasis for all health care providers on prevention and health promotion makes it logical for chiropractic, historically a profession that promotes the body's natural healing capacity, to declare a role in this arena. In *The Future of Chiropractic Revisited: 2005–2015*, one possible scenario for the profession is "healthy life doctor," where chiropractors combine their historical emphasis on the importance of spinal manipulation in promoting wellness and preventing disease with the growing body of scientific evidence on health promotion and prevention, thus combining the "best of both worlds."[7]

If the profession emphasizes a wellness model of practice, it is essential that it be an evidence-based model consistent with mainstream health promotion and prevention.[29–34] Such a model has been proposed to contain the following practice components:[35]

- Manual procedures to promote optimal function
- Screening for risk factors, including tobacco use, physical inactivity, and obesity
- Health behavior counseling to promote health and prevent disease and injury

Screening and counseling should be based on the most up-to-date recommendations, which are available from the U.S. Preventive Services Task Force at its website (http://www.ahrq.gov/clinic/USpstfix.htm) or in its publication, *Guide to Clinical Preventive Services*.[23] At a minimum, chiropractors should include screening and counseling related to the health indicators most relevant to usual chiropractic practice, the majority of which deals with musculoskeletal health:

- *Physical activity:* The connection between physical activity and the musculoskeletal system is obvious. In a 2004 survey of U.S. chiropractors, 89% of respondents reported that they provided information on exercise for fitness and disease prevention, and 87% stated that they obtained information on patients' physical activity status in order to identify those at risk.[11]
- *Overweight and obesity:* Physical activity is a key element in obesity prevention and reduction, along with basic nutrition. In the same survey, 83% of responding chiropractors reported that they provided information about diet to enhance health, and 83% reported that they obtained information about overweight/obesity in order to identify at-risk patients.[11]
- *Tobacco use:* Tobacco use is the most important modifiable risk factor for the leading causes of premature death, and it has also been associated with poorer outcomes for low back pain and disability.[36] In the survey mentioned in the previous indicators, the majority of chiropractors (73%) reported that they obtain information from patients on smoking status, but fewer (65%) reported providing information about the dangers of smoking or quitting to at-risk patients.[11] Like other providers, this may be because of time constraints or lack of knowledge about health behavior modification.[37,38] Additionally, chiropractic colleges do not currently systematically train chiropractic interns to address patients' tobacco use issues.[39]
- *Injury and violence:* Chiropractors see many patients with unintentional injuries, particularly those caused by motor vehicles and falls; 83% of chiropractors in the survey described earlier reported that they provide information on injury prevention to patients, although far fewer obtain information to identify at-risk patients

(seat belt use, 55%; bicycle or motorcycle helmet use, 37%).[11]

Two significant steps toward integration of chiropractic into the public health arena will therefore be (1) to ensure that chiropractors are following nationally recognized recommendations on screening and counseling in these areas, and (2) to form alliances with local or national organizations to provide patients with the prevention and health promotion resources they need and to provide a means for chiropractors to contribute to community activities in these areas.

USING HEALTHY PEOPLE 2010 AS A ROADMAP TO INTEGRATING CHIROPRACTIC PRACTICE INTO THE PUBLIC HEALTH ARENA

> Healthy People 2010 seeks to increase life expectancy and quality of life over the next 10 years by helping individuals gain the knowledge, motivation, and opportunities they need to make informed decisions about their health. At the same time, Healthy People 2010 encourages local and state leaders to develop communitywide and statewide efforts that promote healthy behaviors, create healthy environments, and increase access to high-quality health care.[8]

Health care providers are in a position to contribute to national health objectives in several different ways. As described earlier in this chapter, their usual role is to participate in public health activities at the level of provision of individual health care. This service to individuals may include treatment of disease, disability, or injury; provision of screening services related to disease prevention; and/or provision of counseling on health behavior to assist the patient in preventing disease or injury. Providers can also participate at the level of the community, by participating in, sponsoring, or providing expert input to health promotion activities sponsored by government or other agencies and organizations. The roadmap described here will provide suggestions and information for participation at both these levels.

Becoming integrated with the public health community means that chiropractors have a give-and-take relationship with it: they should utilize public health resources to enhance individual patient care as well as contribute to the good of the community.

Of the 28 focus areas and 467 objectives of Healthy People 2010, the chiropractic community might be best served to concentrate on the focus areas most closely related to the typical chiropractic practice, which emphasizes the importance of musculoskeletal function and health. Individual chiropractors, of course, may have specialized practices or personal interest in any of the focus areas; however, as a profession, integration would be best served by focusing on objectives related to the following health indicators, which were described earlier in the chapter:

- *Focus area 1:* Access to quality health services
- *Focus area 2:* Arthritis, osteoporosis, and chronic back conditions
- *Focus area 12:* Heart disease and stroke (particularly Objective 12.11: Increase the proportion of adults with hypertension who are taking action to help control their blood pressure)
- *Focus area 15:* Injury and violence prevention
- *Focus area 19:* Nutrition and overweight
- *Focus area 20:* Occupational safety and health
- *Focus area 22:* Physical fitness and activity
- *Focus area 27:* Tobacco use

Focus Area 1: Access to Quality Health Services

There are six major components to the continuum of health care: clinical preventive care, primary care, emergency services, specialist care, hospital care, and long-term and rehabilitative care. The focus within the context of this discussion is the role of chiropractors in delivering clinical preventive services. Healthy People 2010 calls attention to the importance of all providers throughout the entire continuum of care increasing their delivery of preventive services to patients of all ages, ethnicities, and economic strata. Clinical preventive services are usually considered to include screening for early disease, counseling on health behavior, and chemoprevention.

The current health care system does not provide adequate screening and counseling for all segments of the population; counseling on health behavior is delivered even less frequently than screening services. However, there is evidence that even brief counseling by physicians is effective in helping patients change a variety of health behaviors, so it is very important that providers of all types become more skilled in health behavior counseling.[23] One of the basic principles of health behavior counseling is that counseling should be tailored to the individual patient's risk factors, needs, preferences, and ability to understand and carry out counseling recommendations.[23] Thus, it is essential that providers collect information about patients' risk factors and other relevant characteristics when they first enter care.

Chiropractors can address the need for screening and health behavior counseling by routinely questioning

Table 18-4 Recommendations for Chiropractic Providers Related to Focus Area 1: Access to Quality Health Services

Objective	Level of Action		Resources
	Individual Patient	***Community***	
1–3. Increase proportion of persons appropriately counseled about health behaviors.	• Identify risk factors. • Provide information on risk factors.	• Identify community resources for counseling. • Refer patients as needed.	• *Guide to Community Preventive Services:* http://www.ahrq.gov/clinic/USpstfix.htm • *Guide to Clinical Preventive Services:* http://www.thecommunityguide.org/library/book/

patients about risk factors and incorporating counseling on health behavior into their care plan, particularly in the focus areas listed in this section. **Table 18-4** summarizes this recommendation and lists important resources to enable the doctor of chiropractic (DC) to implement it. It is not always necessary or feasible to provide counseling in the chiropractic office; DCs should therefore identify and become familiar with valuable community resources that will not only help their patients make needed behavior changes, but also integrate the office into the local health care and public health community.

Focus Area 2: Arthritis, Osteoporosis, and Chronic Back Conditions

Musculoskeletal conditions are responsible for almost one third of disabilities in the U.S. population age 15 or older. In fact, arthritis and back conditions are the first and second leading causes of disability in U.S. adults. Health care expenditures for chronic back conditions have escalated, increasing 65% from 1997 to 2005. The proportion of people reporting spine-related conditions limiting their activities also increased in that time period, from 21% to 25% of U.S. adults.[40] Direct health care costs of back pain and other spine-related conditions for the years 2002–2004 were estimated to be $194 billion.[41]

Arthritis and rheumatic conditions are among the more common conditions of patients who seek chiropractic care.[10] Certainly back pain and other spine-related pain are what chiropractors are most frequently recognized for treating. Thus, it is important that the profession document the part they are already playing in contributing to national public health objectives in this focus area, as shown in **Table 18-5**. Simply making

Table 18-5 Recommendations for Chiropractic Providers Related to Focus Area 2: Arthritis, Osteoporosis, and Chronic Back Conditions

Objective	Level of Action		Resources
	Individual Patient	***Community***	
2–1. Increase number of days without severe pain among adults with chronic joint symptoms. 2–2. Reduce the proportion of adults with chronic joint symptoms who experience a limitation in activity due to arthritis. 2–11. Reduce activity limitation due to chronic back conditions.	• Track pain and disability days using established measures.*	• Support National Arthritis Foundation activities in community. • Use Bone and Joint Decade information and participate in activities.	• *CDC Behavioral Risk Factor Surveillance System:* http://www.cdc.gov/brfss/ • *CDC National Center for Chronic Disease Prevention and Health Promotion, Arthritis Center:* http://www.cdc.gov/arthritis/ • *National Arthritis Foundation:* http://www.arthritis.org • *The Bone and Joint Decade:* http://www.boneandjointdecade.org

*Example: CDC Behavioral Risk Factor Surveillance System questions:

- Are you now limited in any way in any of your usual activities because of arthritis or joint symptoms?
- During the past 30 days, for about how many days did pain make it hard for you to do your usual activities, such as self-care, work, or recreation?

documentation of changes in pain and disability related to arthritis and back and spine pain a routine part of chiropractic practice is an important step toward integration.

At the level of the community, chiropractors can participate in programs developed at the national level and implemented locally. For example, the National Arthritis Action Plan was developed by three national agencies, the CDC, the Association of State and Territorial Health Officials, and the Arthritis Foundation. This action plan outlines a systematic public health approach to arthritis prevention and management, and offers many ways for health professionals to be involved or to assist their patients to access resources to help them self-manage their condition.

Focus Area 12: Heart Disease and Stroke

Heart disease is the leading cause of death in the United States, [42] and stroke ranks third.[43] Hypertension is a risk factor for both coronary heart disease (CHD) and stroke. Lifestyle interventions have been found to be successful in changing behavior and are now considered a major strategy in the prevention of both heart disease and stroke. Factors that have been shown to prevent hypertension are moderate or greater levels of physical activity, healthy weight maintenance, moderate alcohol intake, low sodium intake, and at least five servings of fruit and vegetables per day. Smoking cessation is also an essential part of heart disease and stroke prevention.

It is essential that chiropractors screen all adult patients for hypertension as well as other risk factors for heart disease and stroke, and counsel them appropriately on reducing these risk factors. Approaches to physical activity, overweight/obesity, and tobacco use are described under Focus Areas 19, 22, and 27. **Table 18-6** specifically addresses Focus Area 12.

Focus Area 15: Injury and Violence Prevention

Injury is the leading cause of death up to age 34. Motor vehicle crashes are the most common type of unintentional injury, except in the population age 65 or older, in whom falls are the most common type of unintentional injury. Injury events have a bimodal distribution, with the younger and older age groups being affected disproportionately.[44,45] In the latter part of the 20th century, the cost of injuries was estimated to be over $440 billion each year, and rising. Many effective injury prevention strategies have been developed and their effectiveness and cost-savings documented.[46]

For example, the following injury prevention strategies have significant cost savings in medical and other related expenditures:[8]

- $1360 saved for each child safety seat in use
- $900 saved for each smoke detector in use
- $395 for each bicycle helmet in use

Although intentional injuries are a significant public health concern as well, most chiropractors will have greater impact focusing on unintentional injuries. However, it should be noted that in most locations in the United States, it is required that all providers report cases of child, elder, and domestic partner abuse.

Prevention of unintentional injuries is a complex and multifactorial endeavor, requiring cooperation of individuals, families, health care providers, and local and national organizations and agencies. Thus, the participation of chiropractors can serve an important function in national injury prevention strategies. **Tables 18-7** and **18-8** summarize several ways in which chiropractors can contribute to injury prevention.

Table 18-6 Recommendations for Chiropractic Providers Related to Focus Area 12: Heart Disease and Stroke

Objective	Level of Action		Resources
	Individual Patient	***Community***	

12–11. Increase proportion of adults with high blood pressure who are taking action to help control their blood pressure.	• Screen all adult patients for hypertension.
	• Screen all adult patients for behavioral risk factors for heart disease and stroke:
	  • Physical inactivity
	  • Tobacco use
	  • Overweight/obesity
	  • Dietary factors
		• Join local "Mission Possible" activities of the National High Blood Pressure Program.
		• Offer community blood pressure screenings.
			• *National High Blood Pressure Education Program of the National Heart, Lung and Blood nstitute of the National Institutes of Health:* http://www.nhlbi.nih.gov/about/nhbpep/index.htm

Table 18-7 Recommendations for Chiropractic Providers Related to Focus Area 15: Injury and Violence Prevention—Prevention of Transportation-Related Injuries

Objective	Level of Action		Resources
	Individual Patient	*Community*	
15–19. Increase use of safety belts 15–20, 22, 23. Increase use of child restraints, motorcycle and bicycle helmets.	• Include questions on safety belts, car seats, and bike and motorcycle helmets in new patient history. • Provide child passenger safety fact sheets in waiting room.	• Contact state public health department to participate in community injury surveillance and prevention activities.	• *CDC Injury, Violence, and Safety resources:* http://www.cdc.gov/InjuryViolenceSafety/ • *CDC Injury Fact Book (downloadable):* http://www.cdc.gov/ncipc/fact_book/InjuryBook2006.pdf • *Child Passenger Safety Fact Sheet (printable):* http://www.cdc.gov/ncipc/factsheets/childpas.htm

Focus Area 19: Nutrition and Overweight

Nutrition is a broad, complex, and often controversial topic that relates to almost every aspect of public health, health promotion, and prevention. However, there are a few basic issues related to nutrition on which all providers, agencies, and organizations can come together in order to advance the health of the public: increasing the intake of fruits, vegetables, and whole grains and decreasing empty calories, especially high-fat, high-sugar junk foods. Chiropractors can join with other providers, as well as businesses, schools, and even grocery stores, to promote the CDC's "Fruits and Veggies: More Matters" initiative (formerly "5 a Day for Better Health"). This initiative is a public-private agency partnership designed to increase the fruit and vegetable consumption of Americans. **Table 18-9** summarizes approaches to helping individual patients and the community.

Focus Area 20: Occupational Safety and Health

Concerning Objective 20.2 (Reduce work-related injuries resulting in medical treatment, lost time from work, or restricted work activity), Healthy People 2010 states that, for 1997, 6.6 workers per 100 full-time workers experienced work-related injuries that caused lost work time, health care treatment, or restricted work.[8] Although this is a significant public health problem, prevention strategies have not been fully developed.

Similarly, for Objective 20.3 (Reduce the rate of injury and illness cases involving days away from work due to overexertion or repetitive motion), even though over 3 million workers are exposed to work settings with high risk of injury due to lifting overexertion and repetitive motion, highly effective prevention strategies have

Table 18-8 Recommendations for Chiropractic Providers Related to Focus Area 15: Injury and Violence Prevention—Prevention of Falls in Older Adults

Objective	Level of Action		Resources
	Individual Patient	*Community*	

15–27. Reduce deaths from falls.
15–28. Reduce hip fractures among older adults.
	• Obtain a fall history from all older adults.
	• Obtain information on risk factors for falls, especially:
	  • Medications
	  • Fluid intake
	  • Lower body weakness
	  • Balance and gait problems
		• Establish collaboration with local health departments providing exercise and other fall prevention programs.	• *CDC fall prevention brochures (downloadable):* http://www.cdc.gov/HomeandRecreationalSafety/Falls/index-pr.html

Table 18-9 Recommendations for Chiropractic Providers Related to the Nutrition Component of Focus Area 19: Nutrition and Overweight

Objective	Level of Action		Resources
	Individual Patient	***Community***	
19–5 and 19–6. Increase proportion of public who consume at least two daily servings of fruit and three daily servings of vegetables.	• Screen all new patients for fruit and vegetable intake. • Stock office with informational materials on fruits and vegetables (often available through local public health departments at no cost).	• Contact local public health department to participate in health fairs and other events. • Work with school groups to offer healthy foods in school vending machines.	• *CDC Fruits and Veggies: More Matters:* http://www.fruitsandveggiesmatter.gov/index.html

yet to be developed. For both these objectives, chiropractors have the opportunity to develop partnerships with various industries to provide services that not only would provide treatment to injured workers, but also might identify unique and innovative strategies for prevention of work-related disability.

Focus Area 22: Physical Fitness and Activity

It is now well known that even moderate, not just strenuous, physical activity is protective against heart disease, diabetes, colon cancer, and hypertension.[46] Current recommendations for physical activity for adults are:

- *Aerobic exercise:* Either 30 minutes of moderate-intensity activity per day, most days each week, or 20 minutes of vigorous-intensity activity 3 days a week
- *Strength-building exercise:* 8–12 repetitions of six to eight strength training exercises 2 days per week

Because of the great health impact of physical activity, it is important that health care providers not only encourage individual patients to become active, but also function as community resources and contribute to community activities in this area. **Table 18-10** illustrates examples of such opportunities.

Focus Area 27: Tobacco Use

Medical costs associated with smoking are estimated to be $50 to $73 billion annually.[47] Tobacco use is increasingly being addressed through community-based interventions rather than through focusing on individual behavior alone. However, counseling by providers to individual patients who use tobacco is still an essential

Table 18-10 Recommendations for Chiropractic Providers Related to Focus Area 22: Physical Fitness and Activity

Objective	Level of Action		Resources
	Individual Patient	***Community***	

22–1. Reduce the proportion of adults who engage in no leisure-time physical activity.
22–4. Increase the proportion of adults who perform physical activities that enhance and maintain muscular strength and endurance.
22–5. Increase the proportion of adults who perform physical activities that enhance and maintain flexibility.
	• Screen all patients for level of physical activity.
	• Encourage physically inactive patients to become active:
	  • Exercise prescriptions
	  • Pedometers
	  • Mall walks
	• Provide individually tailored exercise programs based on CDC *Guide to Community Preventive Services*.
		• Contact local health departments, schools, or senior centers to collaborate with local physical activity program implementation.	• *CDC Guide to Community Preventive Services on physical activity:* http://www.thecommunityguide.org/pa/index.html

Table 18-11 Recommendations for Chiropractic Providers Related to Focus Area 27: Tobacco Use

Objective	Level of Action		Resources
	Individual Patient	***Community***	

27–5. Increase smoking cessation attempts by adult smokers.	• Ask all patients if they use tobacco.
	• Provide information on quitting to all users (available from U.S. DHHS).
		• Link all tobacco users to community resources for quitting:
		  • Quitlines
		  • Local health departments
			• *U.S. Department of Health and Human Services Treating Tobacco Use and Dependence: 2008:* http://www.surgeongeneral.gov/tobacco/
			• Quitlines:
			  • http://www.infoline.org/InformationLibrary/Documents/StateSmoking-Quitlines.asp
			  • http://www.naquitline.org/index.asp?dbsection=map&dbid=1
			  • http://www.trytostop.org

part of the overall scheme for decreasing tobacco use. It is important that providers both counsel patients and link them to the considerable community resources available to assist them in quitting. **Table 18-11** summarizes the individual and community approaches appropriate for chiropractors to help their patients.

CONCLUSION

"Learning how to engage more effectively with communities is essential for health professionals who wish to create programs and institute policies that measurably improve health and lives."[48] This is especially true for chiropractic, which evolved as a profession and still educates its students in relative isolation from the health care mainstream. The profession's traditional emphasis on health and wellness, however, could serve as a mechanism for integration, given the rise of chronic disease and the current emphasis on prevention and health promotion in the mainstream. Using the Healthy People initiative as a roadmap for integration, the chiropractic profession can greatly enhance not only its integration into the existing health care system and expansion into the community, but also its ability to serve the needs of its patient population.

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Glossary

Glossary of commonly used public health terms

Absorption—The process of taking something in. Chemicals can be absorbed into the bloodstream and then transported to other organs via the skin, the lungs, or swallowing.

Acceptable risk—The outlook that the consequences of an event are more beneficial than the associated risks, so that individuals or groups are willing to become exposed to the event.

Access—The capacity for people to obtain health care services when needed.

Activities of daily living (ADL)—The tasks carried out by a person in the course of a normal day, such as bathing, dressing, eating, and walking.

Acute care—Treatment of a condition or disease over a short time period, usually for an acute episode of a condition. Typically takes place in acute care facilities at hospitals (i.e., emergency rooms).

Adaptive immunity—Trained immunity characterized by the T-cell and B-cell/antibody response; adaptive immunity is trained through infection (naturally acquired) or immunization (artificially acquired).

Adult day care—The provision of social, recreational, and health-related services in a protective setting to individuals who cannot be left alone during the day because of health care and social needs.

Adverse reaction—An unwanted effect that is attributable to patient care.

Aerobic exercise—Exercise that is intense enough to increase the body's need for oxygen. Aerobic exercise is performed at a moderate intensity level for longer periods of time (i.e., typically longer than 20 minutes).

Agent—A factor (e.g., toxin, microorganism) that, when present in excess (or lacking in a deficiency disease), results in the occurrence of a disease.

Aging—The process of growing older.

Aging of population—An increase in the percentage of older persons in a population as time progresses.

Agricultural pollution—Wastes that are produced by farming; includes pesticides and fertilizers that run off or leach through the soil, dust produced by plowing, and improper disposal of animal and crop by-products.

Air particulates—Suspended particulate matter present in the atmosphere that may be made up of solid particles or liquid droplets; include windblown dust, emissions from industrial processes, smoke from burning wood and coal, and engine exhaust.

Air pollution—The presence of environmental contaminants in the outdoor or indoor air that are harmful to the health of humans, animals, and plants.

Alcohol addiction—The prolonged drinking of excessive amounts of alcoholic drink, which damages health and leads to dependence so that severe withdrawal symptoms occur when the alcoholic person is suddenly deprived of alcohol.

Alcoholic drink—Twelve ounces of beer, 5 ounces of wine, or 1.5 ounces of distilled spirits (80 proof).

Alzheimer's disease—A progressive, degenerative disease that attacks the brain, resulting in impaired memory, thinking, and behavior.

Ambient—Surrounding. When referring to ambient air, it usually means outdoor rather than indoor air.

American Public Health Association—The oldest, largest, and most diverse organization of public health professionals in the world. It aims to protect all Americans and their communities from preventable, serious health threats through health promotion and disease prevention activities.

Anthroponoses—Infections that are carried in and transmitted by humans.

Antibody—A type of protein produced by the immune system in response to a foreign substance (i.e., antigen) entering the body.

Antigen—Any substance (e.g., bacteria, virus, pollen) that causes the immune system to produce antagonistic antibodies.

Antigenic drift—The subtle changes in influenza HA protein epitopes that lead to nearly annual epidemics and are the cause of the need to reformulate the influenza vaccine annually.

Antigenic shift—The major changes in influenza proteins through reassortment (such as replacing H3 with H5) that can cause pandemics.

Asbestos—A fibrous mineral that can pollute the air or water that has been used widely in manufacturing and construction. Its use has been banned or severely restricted by the Environmental Protection Agency (EPA) because it can cause cancer or asbestosis when inhaled.

ASSIST (Alcohol, Smoking and Substance Involvement Screening Test)—A comprehensive instrument designed to identify psychoactive substance use in individuals who use a number of substances and have varying degrees of substance use.

Assisted living facility—A health care facility that provides a combination of housing and personalized health care in a professionally managed group setting. Assisted living facilities meet the individual needs of persons who require assistance with activities of daily living.

Association—When two or more attributes or events are related to each other in such a way that they change predictably together. A temporal association occurs when events occur at approximately the same time, although they may not actually be related.

At risk—The total number of persons who have the potential to experience the event or outcome of interest.

Attack rate—A measure of infectivity; the proportion of those exposed that develop infection.

Attributable risk—The disease rate in exposed subjects that can be ascribed to an exposure. It is found by subtracting the disease rate of a nonexposed population from the disease rate in an exposed population.

AUDIT—A screening instrument for problematic alcohol use among under-age drinkers.

Autonomy—An ethical principle that can be summarily described as respect for an individual's self-rule and independence from controlling influences, enabling individuals to make reasoned, informed choices and providing respect for confidentiality.

Background level—The naturally occurring concentration of a substance in the environment. In air pollution control, background level refers to the concentration of air pollutants in a specified area during a given period of time prior to the stoppage of a source of emission under control.

Behavior—The manner in which a person acts or conducts themselves in the social and physical environment wherein they reside.

Behavior modification—The use of various learning techniques (e.g., conditioning, reinforcement) to bring about change in a person's behavior.

Behavioral choice—The decisions a person makes regarding how they will act or conduct themselves.

Beneficence—The ethical principle of doing good, which can be applied to all aspects of health care practice and research.

Bias—Anything that causes the conclusions of a study to be systematically different from the truth. Bias may occur in the way data are collected, analyzed, and/or interpreted.

Binge drinking—Consumption of five or more drinks for men, or four or more drinks for women on one occasion on at least 1 day in the past 2 weeks.

Biological uptake—The transfer of hazardous substances from the environment to plants, animals, and humans.

Blood-borne pathogen—Infectious elements in the blood that are transmitted through direct blood-to-blood contact.

Body mass index (BMI)—A person's weight in kilograms divided by their height in meters squared. BMI is a generally reliable indicator of body fatness.

Breastfeeding—An unequalled way of providing ideal food for the healthy growth and development of infants; it is also an integral part of the reproductive process with important implications for the health of mothers. Human breast milk is widely accepted to be the optimal source of nutrition for the newborn infant because it contains all the proteins, lipids, carbohydrates, micronutrients, and trace elements necessary for optimal growth, development, and immune protection.

Burden of disease (illness)—Losses that result from a given health problem in terms of morbidity, mortality, financial costs, or other indicators.

CAGE—An alcohol abuse screening instrument in which "C" represents cut down, "A" annoyed, "G" guilty, and "E" eye opener.

Caloric intake—The total number of calories consumed per day.

Caloric-restricted weight loss diet—Weight loss that is achieved primarily because the number of calories consumed has been restricted.

Calorie—A depiction of the energy-producing potential in food that is defined as a unit of heat equal to the amount of heat required to raise the temperature of one kilogram of water by one degree while at one atmosphere of pressure.

Carcinogen—A substance or agent that is capable of causing cancer.

Caregiver—A person who takes care of some or all facets of an ill person's needs.

Carrier state—Carrying an infectious disease without showing overt signs of infection (inapparent infection).

Case—A person in an epidemiological study who has the disease or condition under investigation. These people are members of the cases group in a case-control study.

Case-control study—A type of epidemiological study in which participants are separated into two groups; members of one group have the disease or condition under study (the cases), while those in the other group do not (the controls). The groups are assessed concerning previous exposure to various factors or the presence of certain traits, and then rates of exposure/traits are compared between cases and controls.

Causal inference—The process of logical reasoning used to determine whether there is sufficient evidence to support a causal relationship between a cause and an effect.

Cause—Refers to a factor that has a direct effect on the occurrence of a disease or condition. The factor could be an intrinsic trait or a behavior of the persons being studied or some event they were exposed to. The cause of an injury can be subdivided into an underlying cause and a direct cause. The underlying cause is what initiates the chain of events that brings about an injury; the direct cause is what produces the physical damage.

Centers for Disease Control and Prevention (CDC)—The primary federal agency for conducting and supporting public health activities in the United States. The CDC is part of the U.S. Department of Health and Human Services and is the premier public health agency in the United States that works to ensure healthy people in a healthy world.

Child maltreatment (abuse)—Any kind of abuse (e.g., physical, emotional, sexual) and/or neglect that occurs to children who are under 18 years of age. Child maltreatment may be due to acts of either commission or omission.

Chlorinated hydrocarbons—A class of broad-spectrum insecticides that linger in the environment and accumulate in the food chain (e.g., DDT and chlordane).

Chronic disease—A condition or illness that persists for a long period of time; usually defined as more than 3 months.

Chronic toxicity—Long-term poisonous human health effects caused by exposure to some substance.

Coefficient of determination (r^2)—The square of the correlation coefficient (r). The coefficient of determination represents the amount of variation in one variable that can be explained by the variation in another variable. It can have only positive values that range from 0.0 to 1.0 because r is squared in the process of calculating the coefficient of determination.

Cohort—A distinct group of people who have something in common, such as being exposed to a common risk factor or being born in the same year.

Cohort study—A type of epidemiological study that follows one or more cohorts forward in time to determine the incidence of new diseases, conditions, and/or deaths that occur. Typically, one cohort is exposed to a risk factor, while the comparison cohort is not. The rates of the measured outcomes are then compared between the groups to see if members of the exposed cohort are more likely to develop the disease or condition.

Coinfection—Infection with more than one disease-causing organism at the same time.

Community—An interacting group of persons living in a common location. Also, a group of persons having a common interest or attribute assembled within a larger populace.

Community health—The actions taken to promote, preserve, and protect health in a community and that group's health status.

Comorbid condition—Diseases or disorders that are in addition to, but secondary to, a primary disease or disorder.

Complementary and alternative medicine (CAM)—Various health care practices and products that are not considered to be part of conventional medicine. CAM examples include chiropractic, acupuncture, and herbal medicines.

Complex carbohydrates—The type of carbohydrates that are found in fruits, vegetables, nuts, seeds, and grains. Complex carbohydrates are made up of chains that consist of three or more single sugar molecules linked together.

Confounding—When an extraneous variable influences the relationship between the variables in an experiment. As a result, the study's conclusion may be the result of a confounding variable rather than the variable under study.

Contaminant—Any physical, chemical, biological, or radiological substance or matter that has an adverse effect on the air, water, or soil.

Continuum of health care—Health care provided at different levels of service and for different purposes, including clinical preventive care, primary care, emergency services, specialist care, hospital care, and long-term and rehabilitative care.

Conventional medicine—Medicine as practiced by medical doctors and doctors of osteopathy, as well as by allied health care providers, such as registered nurses and physical therapists.

Correlation—A measure of the strength of a relationship or association between two variables, which can be positive or negative. In a positive correlation, as one variable increases or decreases, the other variable increases or decreases in the same direction. In a negative correlation, as one variable increases or decreases, the other variable increases or decreases in the opposite direction. Correlation depicts a mathematical relationship between variables, but it does not inform as to whether the change in one variable actually caused the change in the other.

Correlation coefficient (r)—A measure of the strength and direction of any mathematical relationship that may exist between two variables. The value of r ranges from −1.00 to +1.00, with +1.00 representing a perfect positive correlation and −1.00 representing a perfect negative correlation. (Also known as Pearson product-moment correlation.)

Council on Aging—A private nonprofit organization or public agency that serves as a focal point on aging and that conventionally provides supportive services to older adults.

Crossover trial—An experiment in which all subjects receive all exposures or interventions, and the order of the interventions is randomized. The major advantage of crossover trials is minimized confounding due to individual characteristics, because the same person receives each intervention.

Cross-sectional study—A study that collects data on exposures and outcomes simultaneously. The study population includes cases and non-cases and there is no follow-up. Sometimes called a prevalence study because the cases are prevalent rather than incident.

Culture—The beliefs, attitudes, and behaviors that are common in members of a societal group.

DAST (Drug Abuse Screening Test)—A widely used screening test for drug abuse and addiction that is easy to administer, containing only 20 yes/no questions.

Demographic—A statistical representation of a human population or sample broken down by categories such as age, gender, and income.

Determinants of health—Factors that are associated with and may have an impact on the health status of an individual or collectively of a population. Determinants may be inherited (e.g., race, genetic make-up) or acquired (e.g., socioeconomic status, work, or living environment).

Developmental surveillance—A means of identifying at-risk children at an early age, thereby creating the opportunity to employ timely interventional strategies to affect improved outcomes.

Diet—The normal pattern of eating and drinking that is adopted by an individual; in contrast to diet therapy, which refers to a prescribed diet that is designed to treat a disease particular deficiency or disease.

Disability—Impairment of physical or mental function that limits the performance of an individual's life activities.

Disability prevention—Preventing a potentially disabling work injury before it occurs (primary prevention), after an injury has occurred (secondary prevention), or minimizing the consequences of a disability once it has become established (tertiary prevention).

Disease—Deviation from the normal function or structure of any part or system of the body, which may bring about a specific set of symptoms and/or signs.

Disease care—Therapeutic management of persons with disease.

Dissonance—In the wellness consultation, dissonance is achieved by presenting a behavioral cost-benefit analysis to a patient about the risks of their current lifestyle choices and the benefits to be gained by embracing change.

Dose—The amount of exposure to a harmful stress or substance that a person or group experiences over a given period of time.

Dose-response relationship—The amount of change in a measure of health that occurs in a person or group in relation to the amount of exposure to a harmful stress or substance that they experience.

Drinking—The consumption of alcoholic beverages.

- *Moderate drinking:* The consumption of no more than one drink a day for women and no more than two drinks per day for men.
- *Heavy drinking:* The consumption of five or more drinks on the same occasion on each of 5 or more days in the past 30 days.
- *Binge drinking:* The consumption of five or more drinks for men (four or more drinks for women) on one occasion on at least 1 day in the past 2 weeks.

Drug Abuse Screening Test (DAST)—One of the most widely used screening tests for drug abuse and addiction due to its brevity (20 questions), ease of administration, and yes/no simplicity.

Ecologic fallacy—Where findings derived from group data are improperly used to draw a conclusion about an individual.

Ecologic model—A comprehensive model used in health promotion that is aimed more at a macro (population) level. It has constructs that take into consideration the micro issues of the person, as well as the macro issues of the community.

Ecologic study—A type of study in which the unit of analysis is a population as opposed to an individual. Ecologic studies are considered to be observational and are often used in epidemiology.

Ecology—The study of the connections that exist between organisms and the environments they inhabit.

Elder abuse—Intentional or unintentional physical, psychological, sexual, or financial/material maltreatment of persons over 65 years of age that may be due to acts of either commission or omission.

Electric and magnetic fields (EMFs)—Low-frequency radiation that is produced secondary to an electric current flowing through a high-tension wire.

Empty calories—Food energy derived from sources that contain few, if any, nutrients (e.g., vitamins, minerals, fiber).

Endemic—Consistently transmitted (i.e., continuously present) disease within a population.

Environment—The sum of the elements, factors, and conditions in the surroundings that may influence the development, action, or survival of an organism or group of organisms.

Environmental tobacco smoke (ETS)—See *secondhand smoke*.

Epidemic—An outbreak of a disease in a population that gives rise to a higher than expected number of cases.

Epidemiology—The branch of science that investigates the frequency and distribution of diseases in a population with the intention of determining their causes, discovering ways to alleviate them, and preventing their reoccurrence.

Epitope—Antigenic markers to which the immune system responds; in influenza, epitopes on the HA core proteins constantly shift slightly, producing near-annual epidemics and the need to reformulate the vaccine annually.

Etiology—The cause of a particular disease or condition.

Evidence-based care—Health care that draws from a body of scientific evidence to provide better information to both clinicians and patients about the potential benefits of various clinical options for their care, thereby supporting "informed choice" in the health services market.

Evidence-based public health—The use of the best available evidence in making informed decisions about public health practice.

Exercise—Physical exertion for the purpose of training or to improve health. Exercise can result in muscle strengthening, weight loss or maintenance, cardiovascular improvements, and advanced athletic skills. Vigorous

exercise involves a high level of physical activity (e.g., jogging, bicycling, swimming) that typically can be sustained for only short periods of time. Light to moderate exercise involves a lower level of physical activity (e.g., walking, gardening, golfing) that can be sustained for longer periods of time.

Experimental study—A type of study in which subjects are randomly assigned to groups, the researcher manipulates the exposure or intervention, and then the outcomes are compared between subjects who receive the intervention and those in the control or comparison group.

Exposure—An external factor that may have an impact on the health of a person if they are exposed to that factor.

External validity—The extent to which the results of a study can be applied to other patient populations or to "real world" patients. (Also known as generalizability.)

Fetal alcohol syndrome—The result of alcohol consumption during pregnancy that causes physical and mental disabilities, characterized by abnormal facial features, growth deficiencies, and central nervous system problems.

Fitness—The state of being physically fit and healthy as a result of exercise and proper nutrition.

Fluoridation—The addition of fluoride to a water supply in an effort to prevent tooth decay. The desired level of dilution is approximately 1 part fluoride per million parts water.

Fluoride toxicity—An acute reaction to ingestion of a large amount of fluoride (usually 3 mg or more) during a short period of time.

Fomite—An item in the environment that facilitates the transmission of infectious organisms when contaminated, such as a doorknob.

Food additive—Substances (e.g., emulsifiers, preservatives) that are added to foods during processing that can improve qualities like color, texture, and flavor.

Food and Drug Administration (FDA)—A division of the U.S. Department of Health and Human Services that assures the safety of foods and cosmetics, and the safety and efficacy of pharmaceuticals, biological products, and medical devices.

Food fortification—The addition of micronutrients (e.g., vitamins, minerals) to foods in an effort to help people who eat those foods attain their minimum dietary requirements.

Food supplement—The addition of extra nutrients to the diet in pill or capsule form, or added directly to food. Food supplements are intended to supply added vitamins, minerals, fatty acids, or amino acids that may be lacking in a person's diet. (Also known as dietary or nutritional supplement.)

Garbage—See *waste*.

Gatekeeper—A member of a managed care plan's provider network that provides portal of entry care. Patient members are typically required to select one of the primary care doctors on the list to act as their primary physician and often must consult with them prior to referral to a specialist.

Genetic predisposition—An individual's underlying vulnerability to a genetic disease (e.g., sickle cell anemia) or being more susceptible to a common disease (e.g., hypertension, diabetes). A genetic predisposition can also be beneficial, like when a person is less susceptible to a disease due to an inherited genetic pattern or when certain skills are inherited (e.g., athletic ability).

Glycemic index—A measure of the elevation in blood sugar after a meal.

Haddon matrix—A commonly utilized tool in the public health field to develop ideas for preventing injuries that considers four determinants of an injury (the host, the vehicle, the physical environment, and the social environment) in relation to the phases of injury prevention (the pre-event phase, the event phase, and the post-event phase).

Harm—Intentional or unintentional physical and/or psychological injury or damage that occurs to a person or group by means of some agent (e.g., another person, a physical object, an organization).

Hazard—A potential source of harm that can result from a past, current, or future exposure. Sometimes used synonymously with risk factor.

Hazardous substance—Any material that results in a threat to human health and/or the environment.

Hazardous waste—Substances that are released into the environment that are potentially harmful to health.

Health—A state of complete physical, social, and mental well-being, and not merely the absence of disease or infirmity (as defined in the WHO constitution of 1948).

Health Belief Model—Ways to get people to take action on improving their health, especially to submit to a screening test. The model consists of six constructs: (1) perceived susceptibility: the person must recognize that they may be susceptible to the disease; (2) perceived severity: whether the person deems the condition to be

severe enough to take action; (3) perceived benefits: what the person would likely gain from taking the preventative health action; (4) perceived barriers: obstacles that may discourage the person from taking action; (5) cues to action: enticements that may prompt the person to take action; and (6) self-efficacy: the level of confidence the person has that they can carry out the health action.

Health care—Services delivered by the health profession to individuals and communities in order to preserve and restore mental and physical health by preventing or treating disease. Acute care, for example, attempts to minimize the immediate harm of an illness/injury, whereas the intent of rehabilitative care is to restore the patient to optimal function.

Health care intervention—An effort to encourage positive health behaviors such as exercise, to discourage unhealthy habits such as tobacco use, or to prevent transmission of communicable disease. The objective of a health care intervention may also be the restoration of some measure of health or function lost through illness or injury, as well as efforts to reduce or relieve pain.

Health care system—An organized approach to improving the health of a population through the delivery of various services and programs.

Health disparity—Significant differences between socioeconomic groups regarding a given health indicator that persist over time.

Health education—The communication of information intended to improve knowledge about health in order to encourage people to take action to improve their health.

Health indicator—A measure that denotes the health status of members in a defined population; disease rates, for example.

Health insurance—Protection against loss due to medical expenses incurred for the treatment of illness or injury.

Health maintenance organization (HMO)—A type of managed care plan in which an enrolled population is provided comprehensive health care services through contracted or directly employed health care providers. Each plan member must typically choose a primary care physician from a list of member providers for initial contact regarding health care concerns.

Health plan—A business entity that functions as insurer for a population of enrollees.

Health promotion—The process of improving the health of a population by enabling people to increase control over their health, as well as to improve their health through activities, such as education and legislation.

Health protection—Actions carried out by individuals, communities, government agencies, and the like that are designed to prevent or reduce the incidence of disease in a population. Examples include automotive safety programs and efforts to control outbreaks of a communicable disease.

Health services research—Investigates the relationships among the need, demand, supply, use, and outcome of health services. Health services research involves various branches of science, including epidemiology, economics, and sociology.

Healthy lifestyle behavior—Actions carried out by an individual that have the potential to bring about improved health, such as starting an exercise program or stopping smoking.

Healthy People—A statement produced by the U.S. Department of Health and Human Services. Healthy People 2010 consisting of 28 focus areas and 467 national health objectives designed to identify the most significant preventable threats to health in the United States and to establish national goals to reduce these threats by 2010. It is important to note that Healthy People 2010 focuses on disease prevention and health promotion rather than disease treatment. The Healthy People initiative began in 1979 and the most current version is Healthy People 2020.

Heavy drinking—Having five or more drinks on the same occasion on each of 5 or more days in the past 30 days.

Heavy metals—Metallic elements that have high atomic weights and can harm living things at low concentrations. Heavy metals tend to accumulate in the food chain. Examples include arsenic, lead, and mercury.

Herd immunity—When a large proportion of a population is vaccinated against a particular infectious disease, individuals who are not vaccinated are provided a degree of protection because there is less opportunity for the disease to spread within the community.

High risk group—A group within a community that has an elevated risk of developing a particular health problem.

Hill's Criteria of Causation—A list of criteria offered by Sir Bradford Hill that are often used to help establish whether a cause-and-effect relationship exists. Hill's criteria are as follows:

- *Strength of association:* The stronger the association between a risk factor and an outcome is, the less likely it was caused by other factors.

- *Consistency:* The duplication of study results by different researchers in a different setting.
- *Specificity in the cause:* Ideally, the exposure should be associated with a single specific disease.
- *Temporality:* The exposure must precede the disease.
- *Dose-response relationship:* Increased exposures should correspond to increased risk of disease.
- *Plausibility:* There should be a rational scientific basis for the association.
- *Coherence:* The association must be consistent with other knowledge on the topic.
- *Experimental evidence:* Research that is based on experiments reinforces a causal inference.
- *Analogy:* The association is analogous to a known causal relationship.

Holistic—A health care approach that attends to the whole person and their relationship to their environment, as opposed to a reductionistic approach, which deals with single elements or systems of the body.

Hospice—A facility capable of providing care that addresses the physical, spiritual, emotional, psychological, social, financial, and legal needs of the dying patient and his or her family.

Host—An organism that is infected by a parasitic or pathogenic organism. An organism that a parasite inhabits and obtains its nutrition from.

Hygiene—The science that is concerned with the prevention of illness and preservation of health.

Iatrogenic—A health care–induced injury, disease, or condition.

Idiopathic—An injury, disease, or condition for which the cause is not determinable.

Immunity—Protection against a particular disease; it can be passive, where the individual's immune system produces the antibodies, or active, where immunity is derived from antibodies produced outside the body.

Immunization—The process by which a person receives protection against a disease; often by means of vaccination.

Immunogenic—Capable of stimulating a response from the adaptive immune system.

Impairment—A physical or mental fault that may lead to disability.

Inapparent infection—An asymptomatic infection that can be associated with the carrier state.

Incidence—The number of newly diagnosed cases of a disease within a specified population during a specified time period, which is typically one year. The denominator is the population under consideration and the numerator is the number of new cases that develop during the given time period. The incidence rate may be calculated by dividing the number of new cases of a disease in a given time period by the number of persons in the population who are at risk for the disease.

Incubation period—The time period in which an infectious organism is multiplying within the host before clinical disease is manifest. (Also known as latency period.)

Indicators of child abuse—Evidence that a child has been victimized, including physical (e.g., scars, bruising, burns), behavioral (e.g., antisocial behavior, lack of emotion, insecurity), and nonspecific indicators (e.g., sleep disorders, school difficulties, self harm).

Indoor air pollution—Chemical, physical, or biological contaminants that are present in indoor air.

Infection—The invasion of body tissues by pathogenic microorganisms that are capable of causing disease, and the subsequent tissue response that occurs.

Infectious disease—A disease that is transmissible from one person to another by direct or indirect contact. (Also known as contagious disease, communicable disease.)

Infectivity—The ability of an infectious organism to produce infection in humans.

Informed consent—The agreement by a patient to undergo treatment or to participate in an experiment after understanding the benefits, as well as the risks involved.

Injury—Damage to the body resulting from acute exposure to thermal, mechanical, electrical, or chemical energy or from the absence of such essentials as heat or oxygen.

- *Intentional injury:* The result of deliberately inflicted harm; also referred to as violence.
- *Unintentional injury:* Unrelated to any deliberate actions, although it is often the result of neglect (e.g., not fastening safety belts). Unintentional injury is sometimes incorrectly referred to as accidental injury.
- *Injury control:* The amalgamation of injury prevention, acute care, and rehabilitation strategies.
- *Injury spectrum:* The mapping of an injury over time, beginning with the exposure of the host to some hazard, followed by the event, then the injury itself, and lastly the possible disability or death that may result.
- *Spectrum of injury:* The range of severity that injuries can span (e.g., from mild to severe).

Injury cause (underlying and direct)—The underlying cause of an injury is what initiates the chain of events that brings about an injury. The direct cause is what produces the physical damage.

Innate immunity—The rapidly responding but generic immune system response, which can activate and guide the more specific adaptive immune system.

Inoculum—The infecting dose.

Intent-to-treat analysis—Study participants are kept in their assigned treatment groups regardless of compliance, thus preserving the baseline comparability.

Intermediate care facility (ICF)—A nursing home that provides medical care at a less intensive level than a skilled nursing facility, although daily nursing services are still available.

Internal validity—The degree to which systematic error (bias) and confounding have been controlled in a study. The capacity of an experiment to show that the independent variables actually caused the changes that were observed in the dependent variables.

Irritant—Any substance that can irritate the eyes, skin, or respiratory system. The effects of irritants may be acute from a single high-dose exposure, or chronic from repeated low-dose exposures.

Latency period—See *incubation period*.

Life expectancy—The number of years an individual is expected to live. Potential life expectancy is the genetically determined maximum life span, whereas actual life expectancy is the true life span, which is almost certainly cut short due to illness and injury. In epidemiology, life expectancy is the average length of life of persons in a population.

Life span—A person's length of life.

Lifestyle—A way of living that reflects the values and attitudes of a person or group.

Lifetime exposure—The total accumulated amount of exposure to a substance that a human would receive in a lifetime, which is generally considered to be 70 years.

Lifetime prevalence—The proportion of a population that experiences a given condition at some point in their lifetime.

Liquid calories—Calories derived from drinks that are commonly sweetened with high-fructose corn syrup or sucrose (e.g., soft drinks, fruit juices). Liquid calories do not satisfy hunger as well as those derived from food, which may lead to calorie overconsumption.

Locus of control—The perception a patient has about who is ultimately responsible for making decisions about their health. Patients with an internal locus of control tend to believe that their behavior is guided by their own personal choices, whereas those with an external locus of control believe that their behavior is guided by external circumstances.

Long-term care—Health and social services that are provided on an ongoing basis to persons with chronic physical and/or mental disabilities. Long-term care may be provided in an institution, as well as in the person's home.

Managed care—A health care agreement wherein an organization acts a middleman between those seeking care and the providers. Managed care examples include health maintenance organizations (HMOs) and preferred provider organizations (PPOs).

Matching—The assignment of subjects to groups in a way in which subjects are paired based on one or more variables, such as age, sex, condition severity, and so on. Matching can reduce the effects of selection bias by making groups more similar.

Maximal medical improvement—The point in time at which little or no further change is expected in a patient's condition.

Medical Expenditure Panel Survey (MEPS)—A collection of large-scale surveys of families and individuals, as well as their medical providers, and employers across the United States. It is considered to be the most complete source of data on the cost and use of health care and health insurance coverage in the United States.

Mixing vessels—Swine and humans, both of which are able to be infected with their own influenza strains as well as avian strains, providing the opportunity for coinfection and reassortment.

Moderate drinking—Having no more than one drink a day for women and no more than two drinks per day for men.

Monitoring—Surveillance or testing of a population or environs to determine the level of pollutants and/or compliance with statutory requirements.

Morbidity—A diseased condition or state; sickness; the incidence of disease within a population.

Mortality—Death; cessation of life.

Mortality rate—A ratio of the number of deaths relative to the total population during a specified time period. (Also known as death rate.)

Motivation to change—When the patient is made acutely aware of the risks of not changing a deleterious health habit, actively explores the benefits of changing, and is given the opportunity to select their preferred intervention from a variety options.

Motor vehicle crash (MVC)—The impact of one motor vehicle with another object (e.g., automobile, power pole, rollover impact with the ground) that is usually unintentional. MVCs may result in injury to the vehicle's occupants or to pedestrians. MVCs are a major public health concern that resulted in more than 40,000 deaths in the United States in 2007.

Musculoskeletal disorder—An injury or condition that involves the muscles, tendons, nerves, or supporting structures of the body.

Mutagen—A physical or environmental agent that causes genetic damage.

Mutation—Damage to the genetic structure of living organisms.

National Center for Health Statistics (NCHS)—The principal health statistics agency in the United States that compiles statistical information to guide actions and policies to improve the health of the people of this nation.

National Health Interview Survey (NHIS)—The primary data source regarding the health of the civilian noninstitutionalized population of the United States. NHIS is one of the chief data gathering programs of the National Center for Health Statistics, which is part of the Centers for Disease Control and Prevention.

National Institutes of Health (NIH)—The primary federal agency for conducting and supporting medical research; it is part of the U.S. Department of Health and Human Services.

Neglect—Not providing a child with needed attention and due care. Examples of neglect include abandonment, failure to provide adequate food/fluid, and failure to supply adequate clothing to protect the child from the elements.

Negotiation—A strategy used to ensure that a wellness plan reflects the patient's aims and values and is not merely the brain child of the practitioner.

Nitrate—Matter that enters the water supply from animal feed lots, agricultural fertilizers, septic systems, industrial waste waters, and sanitary landfills.

Noninfectious disease—A disease that is not contracted by an infectious agent and is not contagious (e.g., skin cancer, heart disease).

Nonmodifiable risk factors—Various traits that may have an effect on a person's health, but are not changeable (e.g., family history and age).

Notifiable disease—A disease required to be reported to the Centers for Disease Control and Prevention when detected through surveillance.

Number needed to harm (NNH)—The inverse of the increased risk of harms. For example, if the treatment raises the risk of harm by 0.5% (0.005), then NNH would be 200 (1/0.005). Depending on the severity of the harm, treatment-related harm in 1 out of every 200 persons treated may be unacceptably large.

Number needed to treat (NNT)—The inverse of the risk difference, which compares treated and untreated (or placebo) groups (i.e., absolute risk reduction). For example, if the risks of adverse outcomes are 0.02 and 0.08, respectively, then, on average, 17 persons (1/0.08–0.02) would have to be treated to prevent one adverse outcome.

Nurses Health Study—An observational study that was started in 1976 and included 238,000 nurses. It is the largest and longest running study of factors that influence women's health.

Obesity—When an adult has a body mass index (BMI) greater than 30 or when a child or teen is at or above the 95th percentile BMI for their age group.

Occupational causation—Establishing whether the origin of an individual's condition was related to his or her employment.

Occupational health—Efforts designed to safeguard the health and safety of employees in their places of work.

Occupational health best practices care—Actions carried out by occupational health care providers that give rise to the greatest opportunity for rapid patient improvement and a timely return to work, primarily involving early communication and coordination with employers, establishing return to work as a key outcome, and assuring timely attention is given to clinical and system needs.

Occupational injury/illness—A disease or condition that in some way resulted from an exposure in the workplace, creating a work-related condition.

Odds ratio (OR)—An estimate of the odds of developing a disease given that a person was exposed to a relevant risk factor. It is the odds of being exposed to the risk factor under investigation in the cases divided by the odds of exposure in the control group, which is calculated from data in case-control studies.

Outbreak—The rapid emergence of a disease in a specific population (e.g., infants) or geographic area.

Outcomes research—A subfield of health services research that focuses primarily on patient-oriented outcomes such as physical and psychosocial function, disability, mortality, return to work, overall quality of life, and satisfaction with care. Cost, use, and complications of health care may also be considered in outcomes research.

Pandemic—A very widespread epidemic, such as the 1918 influenza outbreak that may have killed 50 million people globally and the recent H1N1 influenza pandemic that has affected people in many countries throughout the world.

Particulates—Tiny solid or liquid elements (e.g., dust, smoke, and fumes) found in the air or suspended in water.

Pathogenicity—The likelihood an infectious agent will produce symptomatic disease, not just infection.

Perinatal—Occurring around the time of birth (before, during, or after).

Personal care—Providing an individual assistance with eating, dressing, walking, and other personal needs but with very little or no nursing care. (Also known as custodial care or adult care.)

Physical activity—Any movement of the body that uses energy (e.g., walking, gardening, dancing). Adults should engage in at least 30 minutes of moderate physical activity at least 5 days per week.

Pollution—Matter or energy (usually man-made or man-induced) in the environment that produces unwanted environmental effects.

Population—Individuals residing within a specified area or having similar features (e.g., age, occupation). In research, population refers to the units from which a sample is drawn and to whom the data will be generalized.

Population health—The actions taken to promote, preserve, and protect health in a nondefined group (e.g., a population) and its health status.

Population medicine—Investigation of the distribution and determinants of health and disease, mortality, and morbidity in populations. (Also known as epidemiology.)

Potable water—Water that is considered safe for drinking and cooking.

Predisposition—See *genetic predisposition*.

Preferred provider organization (PPO)—A type of health care plan in which the services of a network of health care providers are made available to enrollees at costs that are lower than the services of providers outside of the network. In contrast to an HMO, enrollees of a PPO are typically allowed to choose any network provider whenever they want.

Prenatal supplements—Vitamin-mineral supplements that are designed specifically to support the special needs of pregnant women, typically including extra amounts of folic acid and iron.

Prevalence—A measure of the burden of a health condition in a population. It is the number of persons in a population who have a given disease or attribute at a particular point in time (point prevalence), over a specified period of time (period prevalence), or over a lifetime (lifetime prevalence). The prevalence rate is calculated by dividing the total number of cases of a disease within a population by the total population.

Prevention—Preemptive actions directed at avoiding the occurrence of an adverse health event or, if it has occurred, to minimize the resulting harm. Prevention involves upstream approaches (looking to the actual cause of disease before it has manifested itself within a population) and downstream approaches (looking onward after a disease has manifested itself within a population).

- *Primary prevention:* Prevention efforts are focused on keeping the healthy in a healthy state.
- *Secondary prevention:* Efforts are aimed at early detection of a disease in order to design ways to prevent its spread.
- *Tertiary prevention:* Efforts are aimed at thwarting the damaging effects of a disease after it has manifested itself within a population.

Primary care—First point of contact health care that is provided by a primary care provider.

Primary care provider—A type of health care provider who is licensed to act as a first point of consultation for all types of patients. Examples include dentists, doctors of chiropractic, and licensed acupuncturists.

Processed foods—Foods that have been modified through various food processing methods in order to make them safer or more convenient. Some of the methods involved in food processing include canning, freezing, refrigeration, and dehydration. Some processed foods are known to have deleterious health effects (e.g., hot dogs), although some food processing methods actually enhance the quality of food and/or make it safer (e.g., pasteurized milk).

Prodrome—A vague or indistinct symptom (such as fever, cough, or malaise) prior to more overt symptoms that would allow clinical identification of the cause of the infection.

Prophylaxis—An action or treatment given prior to the development of a disease that is intended to prevent a disease from occurring.

Prospective study—A study in which data are collected concurrent with the study's progression in time.

Public health—The science and art of promoting health, preventing disease, and prolonging life through the organized efforts of society. (*Health Promotion Glossary*, World Health Organization, Geneva, 1998.) The primary focus of public health is prevention, in contrast to the field of medicine, which emphasizes treatment.

Quality of life—The amount of well-being perceived by a person or group. Health-related quality of life specifically deals with a person or group's physical and mental health.

Quarantine—The isolation of a human (or animal) who has or is suspected of having a disease, in an attempt to prevent the disease from spreading.

Quasi-experimental study—A type of study in which subjects are assigned to groups, the independent variables are manipulated, and outcomes compared; however, random assignment to groups is not involved. Because random assignment is not utilized, it is much more difficult to make claims about causality based on evidence from quasi-experimental studies.

Radiation—The transmission of energy through any medium.

Radon—A radioactive, inert gas that is colorless and naturally occurring. Radon is formed by the radioactive decay of radium atoms in soil or rocks.

Rate—The mathematical relationship between the number of events that occur (e.g., injuries, diseases) over a defined period of time, divided by the population under consideration. Crude rates have not been adjusted for factors that may have influenced the rate, whereas adjusted rates have taken into account one or more demographic factors (e.g., age, gender) in the analysis.

Reassortment—In influenza viral replication, the process whereby core proteins (HA and/or NA) from one strain exchange core proteins with another strain; when coinfection with a novel strain is present, the possibility exists to produce a pandemic strain of influenza.

Recall bias—Those with the outcome of interest are more likely to recall the exposure accurately than those without the outcome, which may result in differential misclassification of exposure. Blinding participants and researchers to the study hypothesis helps to prevent this type of bias.

Recreational activity—A physical or mental endeavor that amuses, distracts, and/or stimulates.

Refined carbohydrates—Whole grain foods that have been processed by removing the bran and germ, which produces a food with finer texture and extended shelf life, but deficient in certain nutrients, like B vitamins and fiber.

Relational model—The relationship between a patient and physician wherein the physician attempts to understand the patient in various dimensions (e.g., biological, emotional). This model also results in a reciprocal relationship between patient and practitioner in which the patient assumes personal responsibility.

Relative risk (RR)—The probability of the presence of disease in the exposed group, divided by the probability of disease in the unexposed group, which is commonly calculated in cohort studies.

Reservoir—The hosts or locations where infectious organisms live or multiply that permit them to infect other organisms. The four basic reservoirs are humans (for anthroponoses), other organisms (for zoonoses), soil, and water.

Retrospective study—A study in which data were collected from the past (e.g., from medical records).

Return on investment (ROI)—A comparison of dollars invested in a health program to the benefits produced such that ROI equals benefits of the investment minus the amount invested divided by the amount invested.

Return to work—When an employee returns to employment after a period of disability, performing either their former, modified, or entirely new duties.

Risk—The likelihood that a person will experience a given event (e.g., become injured).

Risk difference—The difference in the risk for one group as compared to another. Usually the difference in the risk in an exposed group versus the risk in an unexposed group.

Risk factor—A behavior, environmental exposure, or inherent characteristic of an individual that increases their likelihood of developing a disease or condition. Risk factors may be modifiable (those that can be

avoided or minimized, e.g., poor diet and lack of exercise) or nonmodifiable (those that at-risk persons have no direct control over and cannot avoid, e.g., age and family history).

Risky behavior—Actions of an individual that are associated with a greater vulnerability to a specific disease, injury, or poor health.

Sample—A subset of a population that is selected for a given study.

Sanitation—The implementation of hygienic measures that are intended to protect the public's health.

Sanitization—The practice of making something hygienic; for example, waste removal or disinfecting a surface.

Saturated fat—A type of fat that most commonly originates from an animal and, when consumed in excess, is thought to raise blood cholesterol levels.

Screening—Examination or laboratory procedures performed when the person has no symptoms in order to detect disease at an early stage so the chance of favorable treatment is enhanced.

Secondary care—The second tier of health care in which patients are referred for consultation and/or treatment with a health care specialist.

Secondary data analysis—The use of existing data to investigate research questions or address hypotheses without the need for primary data collection.

Second-hand smoke—Tobacco smoke that is present in the environment, which is passively inhaled by a person who is not smoking. Environmental tobacco smoke emits from the mainstream (exhaled smoke) or the sidestream (the burning portion) of a cigarette, pipe, or cigar.

Sedentary lifestyle—Engaging in no leisure-time physical activity (e.g., exercise, sports, physically active hobbies) in a 2-week period.

Selection bias—Systematic error resulting from the procedures used to select subjects and from factors that influence participation. When the association between exposure and disease is different between study participants and nonparticipants, then selection bias may result. If the exposure–disease association among nonparticipants is unknown (as is usually the case), then the presence of selection bias must be inferred.

Self care—Bathing, dressing, feeding, and toileting oneself.

Senility—A term commonly used by doctors as well as the public to categorize the mental deterioration that may occur with aging.

Sensitivity—The detection of true positive cases—100% sensitivity is the detection of every real case; a test that is 100% sensitive would correctly identify every positive case, though it might be prone to calling negative samples positive (false-positives). (See *specificity*.)

Sentinel surveillance—Surveillance carried out at select sites and by select criteria for more rapid response and more in-depth awareness of health events than traditional surveillance might allow.

Sexual violence—Nonconsensual sexual activity that may involve the completed or attempted penetration of the genital opening, anus, or mouth by the penis, finger, or any other object. Sexual violence may also involve nonpenetrative abusive sexual contact, such as groping, and can even occur without physical contact, as in voyeurism and verbal sexual harassment.

Sidestream smoke—Smoke that is released directly from a smoldering cigarette which contains much higher concentrations of tar, nicotine, and carbon monoxide than mainstream smoke because it has not been filtered by the smoker's lungs.

Skilled nursing facility (SNF)—A facility that provides continuous nursing services for persons who have serious health care needs that are not severe enough to require the rigorous nursing care provided in a hospital.

Smog—Air pollution related to oxidants.

Social hygiene—The hygiene and prevention of disease for groups rather than just individual patients.

Specificity—The detection of true negative cases—100% specificity is the exclusion of every case that is negative; a test that is 100% specific would correctly identify every negative case, though it might be prone to calling positive samples negative (false-negatives). (See *sensitivity*.)

Spectrum of injury—Variation of the severity of injuries (e.g., mild, moderate, severe).

Sports activity—Games that typically involve a degree of physical effort or skill and are often competitive. Sports activities may be carried out for enjoyment and/or financial gain.

Statistical significance—A term that indicates that the results of a study are unlikely to be the result of chance at a specified probability level, leading to rejection of the null hypothesis and acceptance of the research hypothesis. When statistically significant differences are found between groups, the differences are considered to be very likely real rather than due to chance.

Suicidal behavior—A form of self-directed violence that may involve suicidal thoughts, suicide attempts, and completed suicides.

Suicide—The act of taking one's own life.

Surveillance—Observing a specific population and keeping a record of data that may have epidemiological implications, usually with the purpose of detecting disease while it is in its early stages.

Survey—The systematic collection of information from groups of people by means of written questionnaires or oral interviews.

Syndrome—A collection of generic symptoms such as respiratory, gastrointestinal, and so on; these are monitored in syndromic surveillance.

Tai chi—A Chinese martial art that is commonly practiced for health reasons and is fast becoming the most popular form of exercise worldwide. (Also known as tai chi chuan.)

Tertiary care—The third tier of health care in which patients are referred by a secondary care provider for consultation and/or treatment with a tertiary health care specialist, usually in a regional hospital setting. An example of tertiary care would be heart transplantation.

Toxicant—A man-made chemical or substance that presents a risk of harm in organisms that ingest or absorb them.

Toxicology—The study of the nature, detection, and effects of toxic substances in living organisms.

Toxin—A naturally occurring substance that may result in harm to an exposed organism.

Trans-fatty acids—The sum of all unsaturated fatty acids that contain one or more nonconjugated double bonds in a trans configuration.

Trans-theoretical Stages of Change model—Used to evaluate the position of the individual on their level of readiness for a change in behavior. The model has five stages of susceptibility for change:

1. *Precontemplator:* A person who has no intention, desire, or knowledge of a need to change
2. *Contemplator:* A person who may be contemplating a change within a certain period of time
3. *Preparation stage:* A person deciding on what steps to take in order to move to the next level
4. *Action:* A person actually doing something constructive toward changing their behavior
5. *Maintenance:* Occurs after a person has changed and continued the new behavior for 6 months

Triage—The process of grouping people with illness or injury based on their need for immediate health care intervention in relation to the probability of them benefiting from such care. Triage is typically carried out in settings such as emergency rooms and during disasters to identify persons who require immediate attention.

TWEAK—An alcohol abuse screening instrument that can be used to measure high-risk drinking that incorporates infrequent heavy intake and can be used to test for moderate- as well as high-risk drinking. "T" is for tolerance, "W" for worried, "E" for eye openers, and "K" for kut down.

U.S. Department of Health and Human Services (HHS)—The principal agency of the U.S. government for protecting the health of all Americans and providing essential human services, especially for those who are least able to help themselves. There are more than 300 programs and a number of agencies included in the department.

Vaccination—The administration of a weakened or killed infectious organism with the aim of preventing the disease it normally causes.

Vaccine—A suspension of weakened or killed infectious organisms that is administered through needle injections, by mouth, or by aerosol to create immunity to various diseases.

Vector—The animal or insect that transmits an infectious organism to humans; as examples, *ixodid* species ticks transmit the *Borellia burgdorferi* spirochete to humans to produce Lyme disease and *Anopheles* mosquitoes transfer *Plasmodium* parasites to humans to produce malaria.

Victimization (children)—An act that exploits or treats someone unfairly; it has been categorized into three broad groups: the pandemic, such as sibling assault, which it is probably reasonable to assume will at some point affect most children; the acute, including physical abuse, which affects a smaller but still significant number; and the extraordinary, including homicide, which affects only a small number of children.

Violence—The intentional use of physical force or power against oneself (self-directed), another person (interpersonal), or a group or community (collective).

Virulence—The seriousness of a disease once it is present, given that an infectious agent is both infective and pathogenic.

Waist circumference—A measure of the distance around the abdomen, which is a useful tool that can easily be used to assess the relative amount of abdominal fat. A waist circumference greater than 35 inches in

females and 40 inches in males is associated with an increased risk for developing several chronic diseases, such as type II diabetes and heart disease.

Waste—Discarded materials (e.g., food scraps) that are disposed of using waste disposal methods. (Also known as garbage.)

Waste management—The process of collecting, transporting, processing, and recycling or disposing of waste materials.

Web of causation—Interconnected factors that lead to the development of a multicausal disease.

Weight gain—Increased body weight that is typically due to an increase in fat deposits, muscle mass, or fluid.

Wellness—Activities that are designed to improve or sustain function and well-being, as well as to avoid disease and prolong life, such as physical fitness, stress management, and smoking cessation.

Wellness care—Preventative management of the health of persons who do not necessarily manifest symptoms in order to improve or sustain function and well-being, as well as to avoid disease and prolong life.

Work restrictions—Arrangements made by an employer with an impaired worker that allow them to continue in their employment by limiting certain tasks that they are required to perform.

Work time loss—A period of time that an employee is absent from the workplace, which may be due to a disability.

Workers' compensation—A type of insurance mandated by various state and federal governments that covers workers who develop job-related diseases or conditions.

Workers' compensation benefits—Benefits that a person with an occupational injury or illness may receive from their employer or the employer's insurance company, including compensation for lost wages while on disability leave, medical benefits, and compensation for permanent impairment.

Workers' compensation costs—Costs associated with the overall care of injured workers, which can be divided into direct costs (composed of the value of all resources used in the treatment, rehabilitation, and care of a person for an occupational injury or illness) and indirect costs (the total value of economic resources that are lost due to occupational injury or illness-related disability or premature death).

Workplace—A location or setting where people are employed (e.g., a factory or office).

Workplace accommodation—An employer allowing modification of required job tasks for a person with an occupational injury or illness so that the employee is able to work during their recovery.

Zoonoses—Infections that are carried in and transmitted by animals or plants; frequently the source of new emerging infectious diseases.

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