MANUAL OF EPIDEMIOLOGY FOR DISTRICT HEALTH MANAGEMENT

Edited by

J.P. Vaughan

London School of Hygiene and Tropical Medicine
London, England

et

R.H. Morrow

UNDP/World Bank/WHO Special Programme
for Research and Training in Tropical Diseases
World Health Organization
Geneva, Switzerland

World Health Organization
Geneva
1989

WHO Library Cataloguing in Publication Data

Manual of epidemiology for district health management.

1. Epidemiologic methods 2. Epidemiology 3. Community health services—organization & administration
I. Vaughan, J.P. II. Morrow, R.H.

ISBN 92 4 154404 X (NLM Classification: WA 950)

Printed in England

89/7940—J.B. Offset—6000

Contents

Foreword

In clinical medicine, diagnosis is the basis for effective management of the patient. On first contact, the clinician asks about the patient's symptoms, conducts a physical examination and carries out relevant laboratory and other special investigations. On the basis of this initial assessment, treatment is instituted, and the cycle repeated thereafter to monitor the patient's progress and to guide future interventions. Diagnosis, as the foundation and the main pillar of clinical medicine, is a familiar and well accepted notion.

Diagnosis is equally important in public health. Like the clinician, the public health practitioner must establish a diagnosis as the basis for effective action. As the clinician monitors the course of the illness in the patient, so the public health worker must continually assess progress within the community. The most powerful tool at the disposal of public health workers for diagnosis and monitoring of community health is epidemiology. Used skilfully and imaginatively, it can help define the pattern of health and disease within populations and groups, identify environmental, behavioural and other social factors that influence the health of the community, and provide objective assessments of the impact of various interventions.

However, in some respects, epidemiology is the victim of its own success. There is a tendency to assume that epidemiological studies are so complex that they can be carried out effectively only by highly trained specialists supported by skilled statisticians. This image has intimidated many health workers and discouraged the use of this powerful tool in routine public health practice. In many developing countries, there are relatively few professionally trained epidemiologists, and they work mainly in the central offices of ministries of health, in academic institutions and in research institutes. Most of the epidemiological data available in these countries are derived from a few special studies conducted by experts. Little use is made of epidemiological methods in defining and analysing health problems at community level on a routine basis.

Since the historic conference at Alma-Ata at which the representatives of governments identified primary health care as the key to the achievement of health for all by the year 2000, ministries of health have strived to strengthen health services at the community level. Major programmes have been launched and national strategies have been developed to meet this ambitious goal. In order to translate these national plans and strategies into effective action at the community level, health workers need relevant, up-to-date knowledge of the pattern of health and disease, and of their determinants

in each district. In the absence of such data, there is a tendency to tackle public health problems through indiscriminate mass interventions. Such an approach is not only wasteful but has often proved ineffective.

The rational management of health services at the community level demands the imaginative use of epidemiological methods. Most of the available textbooks on epidemiology were written for the use of specialists in the field and there is little material available for the general health worker. This manual fills an important gap by bringing simple but effective epidemiological methods to the attention of public health workers at the district level. It shows how they can use simple techniques to rank health priorities within the community, defining high-risk groups, and identifying risk factors. It describes how this information can be used to design health services that are specifically targeted in relation to the needs of the different groups within the population. It also illustrates how epidemiological indicators can be used to monitor community health services and to evaluate their impact. In covering such a wide range of applications, this manual promises to be a most powerful tool in the hands of health care providers at the community and district levels.

Adetokunbo O. Lucas, M.D.
Carnegie Corporation of New York
United States of America

Preface and acknowledgements

There are a number of good books that set out the essentials of epidemiology and a number of courses—mainly in technically advanced countries—that provide training in epidemiology. However, at present there is little epidemiological advice available that is directly useful to those responsible for health care at the district level—the managers who are responsible for implementing primary health care. This manual attempts to be a practical guide to epidemiology and its relationship to planning, management and evaluation. It emphasizes the use of epidemiological health information in district health planning and shows how to obtain, analyse and make use of this information.

The production of this manual, supported throughout its evolution by the Scientific Working Group on Epidemiology of the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases, has a long history and several experimental versions have been produced. Many different authors contributed sections in previous versions and made helpful comments and suggestions. Those who helped in the writing and revision were: E.H. Goh, K. Hughes, H.P. Lee, J. Losos, K.C. Lun, S. Lwanga, W.O. Phoon, C.Y. Tye and F.K. Wurapa.

The first version was largely developed by Dr F.K. Wurapa and his colleagues at the Tropical Diseases Research Centre in Ndola, Zambia. That version was revised by participants at a workshop held in Singapore in 1983, which was hosted by Professor W.O. Phoon and staff at the Department of Social and Preventive Medicine, University of Singapore. The participants at the workshop were: A.A. Buck, H.M. Gilles, K. Hughes, H.P. Lee, K.C. Lun, R.H. Morrow, W.O. Phoon, J. Storey, J. Teoh, C.Y. Tye and F.K. Wurapa. In addition, many other people with epidemiological experience in developing countries have made very useful comments and provided many ideas for improvements to previous versions.

Professor Phoon and colleagues then undertook the difficult task of producing the first experimental draft for field testing in 1985. During 1985-86 Dr E. Lo, of the Ministry of Health, Malaysia, and a number of district health officers used the manual for six months and provided a formal evaluation of its usefulness. Further assessments were provided by many individuals from countries in Africa, Asia and Latin America. The main conclusion was that the manual needed to be more practical and that it should focus on the planning and management activities that health workers were responsible for within the context of the district health system.

The present publication draws upon the previous experimental version, but a substantial amount of new material has been added and the previous manuscript has been extensively rewritten.

In some respects, this version can still be considered experimental. The editors would welcome comments and suggestions for changes and would particularly like to hear from health workers who have actually used this manual in district health management. Comments should be addressed to: UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases, World Health Organization, 1211 Geneva 27, Switzerland.

CHAPTER 1
District Health Management

1.1 What is a district?

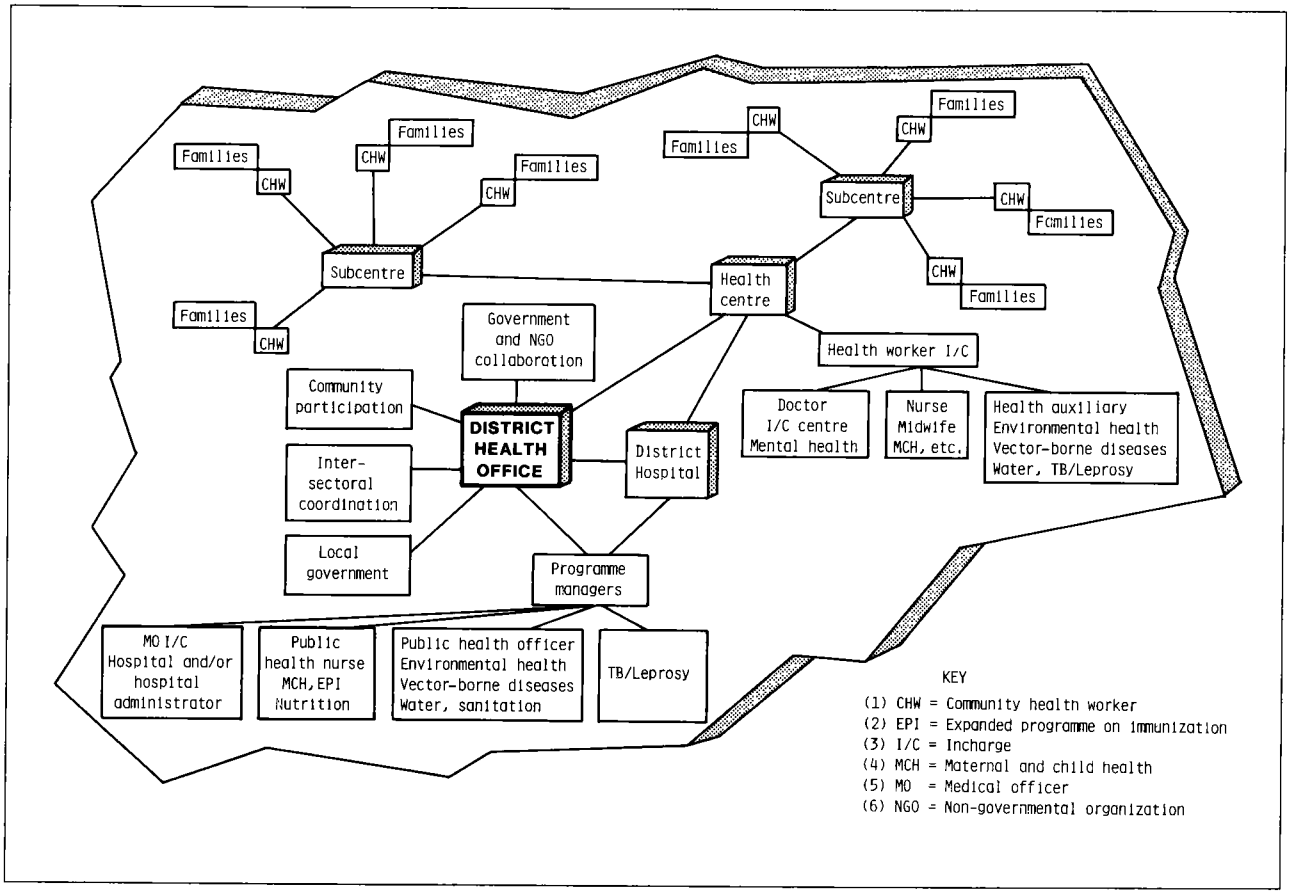
The district is the most peripheral unit of local government and administration that has comprehensive powers and responsibilities. It may be called by various names: the *awraja* in Ethiopia, the block in India, the county in China, the district in Kenya and Malaysia, the *gun* in the Republic of Korea, the *kabupatan* in Indonesia, the municipality in Brazil, the *sharestan* in the Islamic Republic of Iran and the *upazilla* in Bangladesh.

A typical district has a population of between 100 000 and 300 000 people and covers an area of from 5000 to 50 000 square kilometres. The district headquarters is usually in the main town where there are the offices of all the principal ministries that are concerned with district and local affairs, such as health, agriculture, education, social welfare and community development. The district is the natural meeting point for "bottom-up" community planning and organization, and for "top-down" central government planning and development. It is, therefore, a natural place for the local community needs to be reconciled with national priorities.

The district is the key level for the management of primary health care (PHC). Ideally, all health-related activities taking place in the district should be coordinated into a **district health system**. The mix of manpower and facilities providing health care in districts varies greatly from country to country. In the main communities, rural and urban, there may be community health workers, clinics and health centres, together with traditional and private medical practitioners. A government district hospital and the headquarters staff for all the district health programmes are often located in the main town. The district may also have other services run by religious and other nongovernmental organizations.

Figure 1.1 summarizes the general situation that exists in many countries, where the **district health office** is the centre of a network of activities concerned with health, that extend from village level to the main district town. These are the "bottom-up" activities. The national development policies, national health plan and the ministry of health guidelines, priorities and programmes are all examples of "top-down" activities that guide the district health system in its efforts to implement PHC.

Figure 1.1. The central role of the district health office within the district health system



1.2. The district health management team

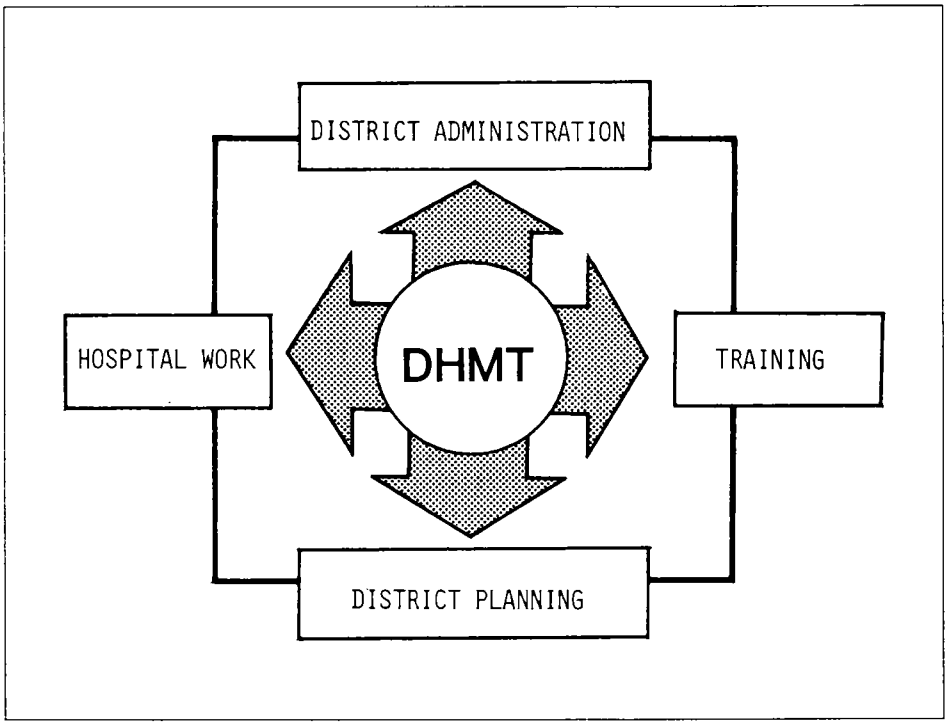
The district health office is usually managed by a team of health workers, called the **district health management team** (DHMT). A typical team consists of the district health officer, public health nurse, hospital administrator, nutritionist and environmental health officer.

The health services extend from the community health workers to the hospitals. The district hospital may be the main centre for curative health care and is commonly referred to as the **first referral level**. As well as organizing the health services, the DHMT also has to collaborate with local government and nongovernmental organizations, to liaise with community representatives and organizations and to practise intersectoral coordination.

It is useful to divide the team's work into four main areas of responsibility:

- District health planning, including community participation, local government and intersectoral coordination and collaboration in health.
- District health administration and the management of all community health programmes.
- Training and supervision of all health staff.
- District hospital and outpatient services.

Figure 1.2. The main responsibilities of the district health management team



If the DHMT is to carry out all these responsibilities effectively, one of its main priorities will be to gather and use a whole range of health information. An understanding of epidemiology is essential for all members of the team, since it will enable them to use health information in health planning, management and evaluation.

1.3 Sources of health information

The starting point for all health information is a good knowledge of the district's population and the total number of people who are "at risk" of needing a service. For example, how many pregnancies occur each year in the district and what percentage of deliveries are supervised by a trained health worker? What proportion of young children are fully vaccinated against measles and tuberculosis? What percentage of households have a reasonable water supply or a toilet?

To answer such questions the DHMT needs epidemiological health information on:

- the population of the district, its age-sex structure, migration and vital statistics.
- the main causes of morbidity and mortality.
- the organization of the district health services, particularly in regard to access, coverage and effectiveness.

Health information is available from a variety of sources. In a few countries the ministry of health may have the information already available for each district; in other countries the information exists, but is scattered in the reports of various ministries or agencies; and in other countries much of the information, particularly maps, census data, demographic and vital statistics, is not available in a form that is usable at the district level, so that the DHMT may have to obtain its own information.

How health information is collected within a district varies considerably from country to country. All countries have a system for collecting data recorded by PHC facilities, which is then collated at the district level and reported to the ministry of health. This **routine health information system** will be more developed and more reliable in some countries than in others.

Health information may also be collected through a **surveillance system** organized by the DHMT for a specific health problem or disease, from the reports and analyses of **epidemics** and from special investigations or **surveys**.

Other useful sources of district health information include health surveys made by the ministry of health, census and demographic surveys made by the bureau of statistics, and data collected by related sectors, such as agriculture and education, and by nongovernmental organizations, such as community and religious groups.

The following is a summary of the information that the district health management team may need:

General information

- The district's history, physical and climatic characteristics, community organization, economic development, people's occupations, and organization of local government.
- Geographical distribution of villages and towns, major roads and important features such as rivers and mountains.

Population

- The district's population size, age and sex structure, geographical distribution, migration patterns and growth rate.

Health status, morbidity and mortality patterns

- Demographic indices for birth and fertility rates and for maternal, infant, child and overall mortality rates.
- Common causes of morbidity, mortality and epidemic diseases.
- Important underlying health problems such as food availability, housing, water supply and excreta disposal.

Health services

- Number and distribution of governmental and nongovernmental facilities, personnel and programmes.
- Adequacy of management support, logistics and supplies.

District health programmes

- Pregnancy: antenatal, delivery and postnatal care.
- Nutrition: growth monitoring and malnutrition.
- Immunization: expanded programme on immunization.
- Environmental health: water supplies, excreta disposal and hygiene.
- Communicable diseases control: cases diagnosed and control activities.

1.4 *Making a community diagnosis*

There is a similarity in approach between clinical medicine and community health. The clinician examines the individual patient and has to recognize and identify the pathological significance of the clinical symptoms and signs in order to make a specific diagnosis and to prescribe the appropriate treatment.

In community health epidemiological skills are needed to examine the whole population and to select the most suitable diagnostic indicators that describe and explain the health problems in the district. It is then necessary to make a community diagnosis and decide which programmes would be most effective in raising the health status of the population.

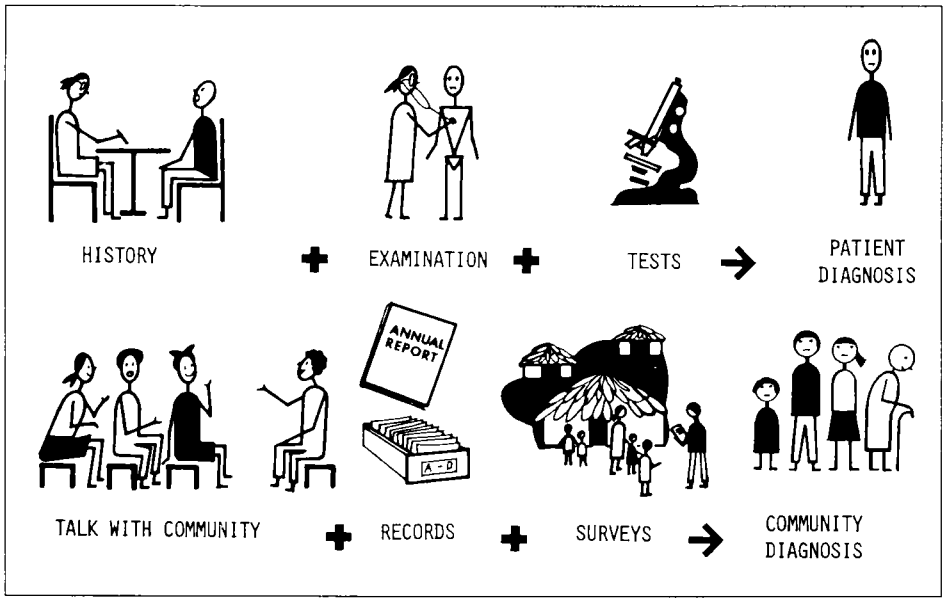
A clinician may order a variety of laboratory or other special tests after making a preliminary assessment of a patient, based on the case history and physical examination. In the same way, the DHMT may need to organize special surveys in order to obtain more epidemiological information than is provided by the routine health information system.

However, there is a fundamental difference in the approach. The clinician usually sees a patient after the disease has started and so treating patients usually does little to reduce the number of new cases of that disease or to remove the underlying health problems. By contrast, the epidemiologist attempts to understand **why** the disease exists in the first place and **how** it can be prevented. Ability to apply the **epidemiological approach** is thus a fundamental skill for all health workers working in community health programmes that aim to reduce disease and improve the community's health status. This comparison is summarized in Table 1.1 and Figure 1.3.

Table 1.1. Comparison of clinical medicine and community health programmes

	Clinical medicine	*Community health programmes*
1. Objective	Cure patient of disease	Improve health status of community
2. Information required	Clinical history, physical examination and	Population data, health problems, disease patterns, availability of health services laboratory investigations
3. Diagnosis	Differential diagnosis and probable diagnosis	Community diagnosis and priorities for action
4. Action plan	Treatment and rehabilitation	Community health programmes
5. Evaluation	Follow-up and assessment	Evaluation of changes in health status

Figure 1.3. Clinical diagnosis and community diagnosis compared



1.5 *Summary of epidemiological and planning responsibilities of the DHMT*

Although the responsibilities of the DHMT will vary from country to country, its duties will involve planning for PHC, including all the promotive, preventive and curative health services. To do this the DHMT will need health information. It is the responsibility of the team, therefore, to obtain this information and then to use it in its work.

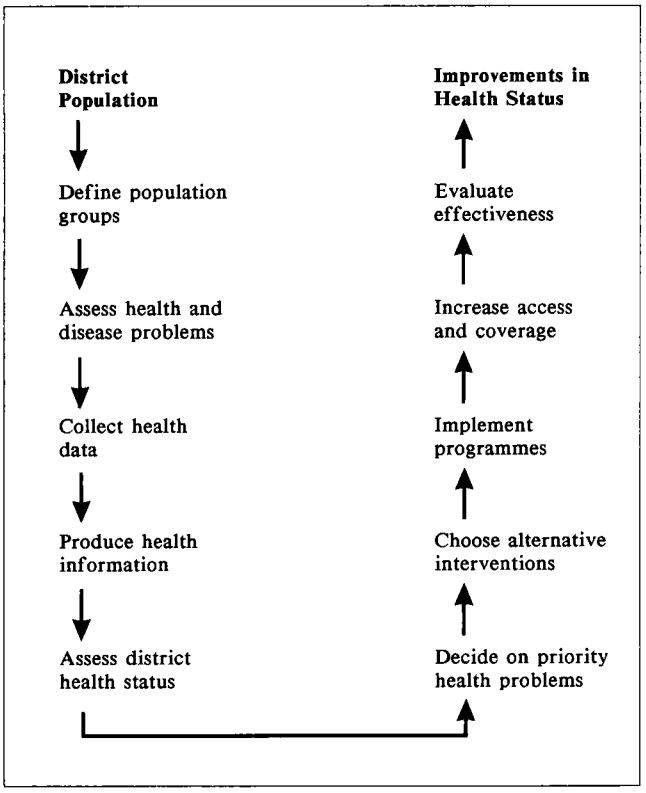
In order to perform the health planning and management cycle, starting with the district population, the DHMT will need epidemiological skills (outlined in Figure 1.4) for the following tasks:

Starting from the district population:

- Define population groups by age, sex and location.
- Assess health and disease problems, particularly important causes of morbidity and mortality.
- Collect health data through routine services, surveillance, epidemics and surveys.
- Produce health information by analysis of data.

- Interpret and communicate the health information.
- Assess the health status of the general population and high-risk groups.
- Decide on the priority health problems.
- Use health information to choose between alternative interventions.
- Implement improvements to health programmes.
- Estimate increase in access and coverage.
- Evaluate effectiveness of health programmes in reducing health problems, morbidity and mortality.
- Determine changes in health status of the district population.

Figure 1.4. Tasks requiring epidemiological and planning skills



CHAPTER 2
Epidemiological Principles

2.1 *Definition and approach*

A useful definition is that **epidemiology is the study of the distribution, frequency and determinants of health problems and disease in human populations. The purpose of epidemiology is to obtain, interpret and use health information to promote health and reduce disease.** The basic epidemiological concepts are highly practical and are relevant not only for the members of the district health management team but for all health workers.

It is useful for the DHMT to consider four phases in the use of the epidemiological approach. The first is **descriptive epidemiology**. It asks: what is the problem and its frequency, who is involved, where and when? In the above definition it is the part concerned with disease distribution and frequency.

The second phase is often called **analytical epidemiology** because it attempts to analyse the causes, or determinants, of diseases by testing hypotheses to answer such questions as: how is the disease caused and why is it continuing?

The third phase is **intervention or experimental epidemiology** in which clinical and community trials are used to answer questions about the effectiveness of new methods for controlling diseases or for improving underlying conditions.

The fourth phase may be called **evaluation epidemiology** because it attempts to measure the effectiveness of different health services

and programmes and to answer the very important question: so what? Have there been any improvements in health status?

The analytical and experimental phases are unlikely to be used by district teams because they rely on complicated research methods, such as case-control and cohort studies and controlled trials. However, descriptive and evaluation epidemiology can be extremely useful and should be widely used by district health staff.

WHO? WHERE? AND WHEN? ARE KEY QUESTIONS FOR SOLVING HEALTH PROBLEMS

Epidemiology is about information: the information needed for planning, managing and evaluating all the activities required to promote health and to prevent and control disease. The key components of the data needed to provide this information can be approached through a series of questions:

What is the health problem, disease or condition, and what are its manifestations and characteristics?

Who is affected, with reference to age, sex, social class, ethnic group, occupation, heredity and personal habits?

Where does the problem occur, in relation to place of residence, geographical distribution and place of exposure?

When does it happen, in terms of days, months, seasons or years?

How does the health problem, disease or condition occur, and what is its association with specific conditions, agents, vectors, sources of infection, susceptible groups and other contributing factors?

Why does it occur, in terms of the reasons for its persistence or occurrence?

So what interventions have been implemented as a result of the information gained and what was their effectiveness? Have there been any improvements in health status?

Although the members of the team are not full-time epidemiologists, they need to know how to base their health work on the needs of the total district population and of special subgroups. To do this they require health information, not only on those who come to the health services but also on those who do not attend.

WHICH POPULATION GROUPS ARE AT HIGH RISK?

A most important concept in epidemiology is that of the total **population at risk**, also called the **denominator population**. It is vital to know about all the people at risk of developing a disease or having a health problem, as well as those who are currently suffering from it. The concept of the denominator is the key to developing the information needed for health planning, management of health programmes and the evaluation of health promotion and disease control activities. For instance, the district team should not only know how many children are immunized each month, or how many patients attended for leprosy treatment, or how many houses were

sprayed with residual insecticide; they also need to know the total number of children, leprosy patients or households that should have received the immunization, treatment or insecticide. A comparison of those who actually received the service with those who should have received it is called **coverage**. Achievement of high coverage by the main programmes is the single most important managerial task of the DHMT. An assessment of the coverage being achieved is the starting point for improvements in district health planning.

WHAT COVERAGE HAS BEEN ACHIEVED?

2.2 *Descriptive epidemiology*

The first stage in understanding a health or disease problem from an epidemiological perspective is to describe it by the characteristics or variables of who? where? and when? After all the information has been assembled, the second stage is an attempt to explain all the facts.

Who?

The most important variables are age, sex, education, occupation, income, cultural and religious group, family size, nutritional state and immune status.

Other groupings might be by such characteristics as clinic attendance and non-attendance, those with latrines and those without, or normal and low-birth-weight infants.

Any relevant variable may be used, provided that subjects can be clearly placed in one category or another.

Where?

The place where people live or work may partly determine which health and disease problems they suffer from and what use they make of the available health services. For example, the variables might be:

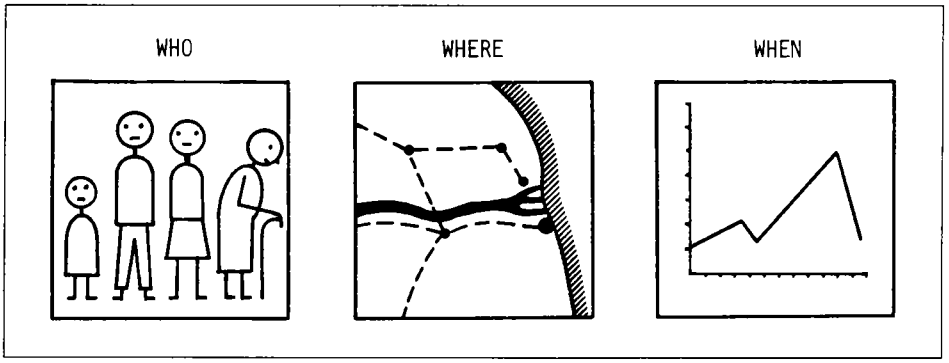
- Town, village or isolated dwelling.
- High or low altitude.
- Proximity to rivers, forests, wild animals or sources of toxic substances.
- Distance from dispensary, health centre or hospital.

When?

It is important to know when health problems are most severe, or when the incidence of new cases is greatest. To show this, cases, episodes or events can be grouped according to new cases per day, week, month or year. The time period depends on what is being analysed, for instance:

- New cases of cholera per day.
- New cases of measles per week.
- New pregnant mothers registering per month.
- New cases of kala-azar in one year.

Figure 2.1. Descriptive epidemiology - who? where? and when?



2.3 *Measuring frequency*

The two main measures of the frequency of diseases, health problems and the use made of health services are **incidence** and **prevalence**. It is most important to be clear about which is being used.

INCIDENCE MEASURES ALL NEW CASES DURING A PERIOD OF TIME

Incidence measures the number of **new** cases, episodes or events occurring over a **defined period of time**, commonly one year. Incidence is the most basic measure of frequency and is the best indicator of whether a condition is decreasing, increasing or remaining static. It is, therefore, the best measure to use in evaluating the effectiveness of health programmes. It is also the measure used in surveillance systems and for analysing how people are using the health services.

Examples include the births and deaths occurring in a district in one year, cases of neonatal tetanus diagnosed per year, number of women attending antenatal clinic for the first time per month, and number of trypanosomiasis cases diagnosed per year.

Prevalence measures the total number of **existing** cases, episodes or events occurring at **one point in time**, commonly on a particular day. Prevalence may be more complicated to interpret than incidence because it depends upon the number of people who have developed their illness in the past and have continued to be ill to the present time. It is a combination of the previous incidence of a condition and its duration. Examples of frequency measured by prevalence are the

total number of leprosy patients on a register at the beginning of each month or the number of hospital beds occupied per day. Whereas prevalence is also very useful for chronic conditions, incidence is more useful for those diseases with a short average duration like measles, diarrhoea, and pneumonia. Cross-sectional surveys generally provide information about prevalence and are particularly useful in establishing information about chronic diseases such as leprosy or schistosomiasis.

PREVALENCE MEASURES ALL CASES AT ONE POINT IN TIME

Under stable conditions, incidence and prevalence are related by the following formula:

prevalence = incidence x average duration of the condition.

Thus for those conditions with a long average duration, such as leprosy and tuberculosis, the incidence per year is much lower than the prevalence. For example, the prevalence rate of pulmonary tuberculosis is commonly between 0.5% and 1.0% (or 5-10 per 1000 people) and the average duration of untreated illness is estimated to be about 4 to 5 years. This means that the incidence of new cases of pulmonary tuberculosis is 0.1% to 0.2% or 1-2 cases per 1000 people per year. In countries with good diagnostic and reporting systems the incidence of new cases of tuberculosis may be used. However, in many developing countries without such systems, reliable information can usually be obtained from cross-sectional surveys which provide prevalence data.

2.4 *Numbers and rates*

Incidence and prevalence are used in reporting health information and may be given as a whole number or a calculated rate.

The most readily available data will be in absolute **numbers.** These are often used in monitoring the occurrence of important infectious diseases, especially in outbreaks, when the populations involved are restricted in time and locality and the population structure can be assumed to be stable.

When we have to look at trends over a period of time, or compare the frequency of diseases between subgroups or communities, using the total number of cases can lead to invalid conclusions. The population size and age-sex structure of each group must also be considered before the groups can be compared and the information should then be expressed in terms of **incidence or prevalence rates.**

When calculating rates, the events or cases are related to the population which has given rise to them. This is the **population at risk** and refers to the group of people who have the potential to get the disease and thus may contribute to the total number of cases. For example, such a "population" may refer to the whole population of a

district or a part of the district or all the people in a particular age-sex group.

The number of cases (made up by counting people, episodes or attendances) is called the **numerator** and the total population at risk the **denominator**. All people in the denominator must be, by definition, at risk of becoming a part of the numerator population. Each rate must have a time period or a date attached to it and this should always be stated.

Incidence and prevalence rates are defined as follows:

$$\text{Incidence rate} = \frac{\text{new cases in specified period of time}}{\text{total population at risk}} \times \text{factor}$$

$$\text{Prevalence rate} = \frac{\text{existing cases at specified point of time}}{\text{total population at risk}} \times \text{factor}$$

The rate is multiplied by a factor, the size of which is chosen so as to enable the rate to be expressed as a suitable whole number; the factor used is commonly 100, 1000, or 10 000.

Example 1: In a district with an estimated mid-year population of 200 000 people, there were 40 cases of kala-azar reported during 1987.

$$\text{Incidence rate} = \frac{40}{200\,000} = 0.0002 \text{ cases per person per year.}$$

Depending on which factor is used, this can be expressed as:

0.02 cases per 100 people per year, or
0.2 cases per 1 000 people per year, or
2.0 cases per 10 000 people per year.

Example 2: On 1 June 1987 there were 120 registered leprosy cases in a district with an estimated population of 200 000 people.

$$\text{Prevalence rate} = \frac{120}{200\,000} \times \text{factor}$$

$$= 0.06 \text{ cases per } 100 \text{ people on 1 June , or}$$
$$0.6 \text{ cases per } 1\,000 \text{ people on 1 June.}$$

The importance of using the appropriate denominator in the calculation of various rates needs to be emphasized. If we are estimating the prevalence rate for a particular disease, then the denominator used should be the total number of individuals who may be at risk of contracting the disease in question. In the case of a sample survey, this denominator may comprise all individuals in the

sample. If, on the other hand, we wish to estimate the "positive" rate for *Plasmodium vivax* from the blood samples that have been collected for the same survey, then the denominator used generally should be the total number of individuals from whom blood samples have been taken and the slides read—not the total sample size.

For age- and sex-specific rates the denominator includes only the people in the relevant age or sex groups. For example, in the age-specific fertility rate for women aged 20-24, the denominator should comprise only females in the study sample who are between the ages of 20 and 24 years.

2.5 People, episodes or attendances?

It is extremely important to be quite clear whether the number of cases is made up by counting people or episodes or attendances. With diseases such as malaria or diarrhoea a person may have several separate attacks in one year and may attend a clinic two or three times for each attack. In this situation, only one person has been ill but he or she has suffered several separate episodes in one year and attended a health service several times for each episode. On the other hand, a tuberculosis patient may only count as one episode and be registered as one case but may have attended 12 times in the past year.

ARE YOU COUNTING PEOPLE, EPISODES OR ATTENDANCES?

What do we count—people, episodes or attendances? If we need to estimate the proportion of the population sick with a chronic disease (prevalence), we should count the total number of sick people. To evaluate the effectiveness of a malaria control programme, we need data on the number of new episodes (incidence) detected, commonly in one year. If we are studying the use of health services, information on new and repeat attendances is usually required.

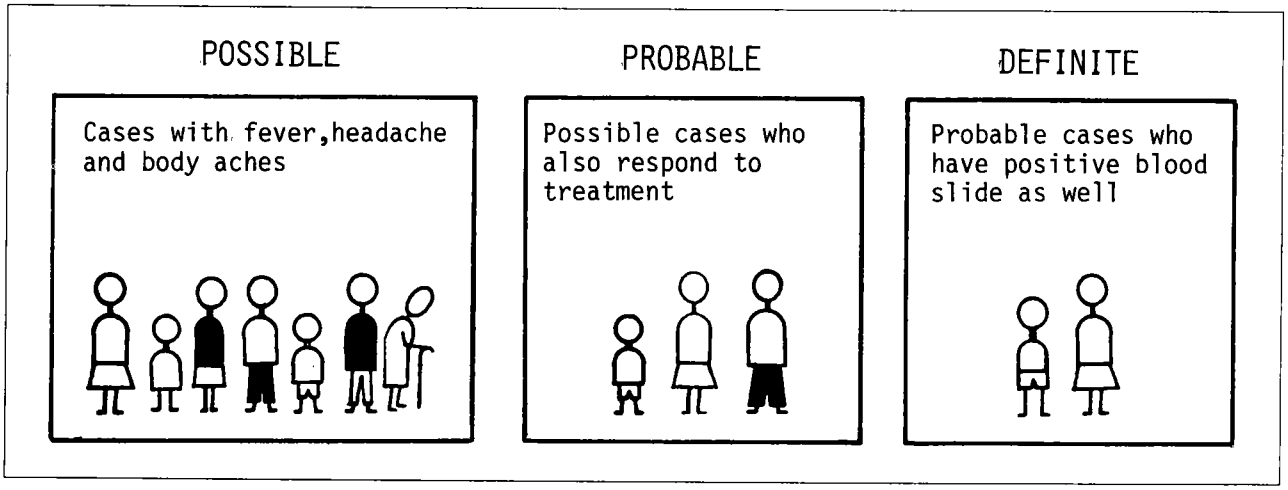
2.6 Defining a case

Before starting to use incidence or prevalence measures, it is most important to decide quite clearly how a case is to be defined. Failure to do this can easily lead to confusion and misunderstandings. For instance, people living in a malaria endemic area with fever, headache and body aches may be called malaria cases and treated as such. However, the ministry of health would probably only accept these as definite cases if they were confirmed by a positive blood slide.

To overcome these problems it is a good practice for some diseases to establish diagnostic criteria and classify cases into several groups, such as possible, probable or definite, accordingly. For example, a patient with a fever, headache and body aches could be said

to be a possible case of malaria; a probable case might be someone who also responded well to antimalarial treatment. Only if there was a positive blood slide for malaria parasites might the case be called a definite one. However, it still has to be recognized that the symptoms might be due to some other illness, particularly in children living in malaria endemic areas.

Figure 2.2. The use of diagnostic criteria to define possible, probable and definite cases of malaria



A poor definition of what constitutes a case, episode or attendance is a frequent problem and one which may lead to false estimates of frequency and to false conclusions about changes in frequency.

2.7 *Making use of rates*

WHAT ARE THE CRITERIA FOR A POSSIBLE, PROBABLE AND DEFINITE CASE?

There are two main reasons for using rates as opposed to whole numbers.

- **To make comparisons** between two different populations that may have different numbers of people at risk, by standardizing for population size. For example, it may be important to make comparisons between several districts or between what is happening now in the district compared with 10 years ago.
- **To calculate the number of expected cases.** By using a known rate (e.g. the national prevalence of leprosy may be 1 per 100 people, or the infant mortality rate 120 per 1000 infants per year), the approximate number of cases that are expected to occur in the district in one year (total leprosy patients and infant deaths) can be calculated.

It is most important for DHMTs to use the best of the known rates to calculate the expected number of cases, since it is these that

the district health services have to serve. Known rates are likely to be more accurate than those calculated from district data. This problem is explained in more detail in Section 4.7.

2.8 Health indicators

RATES ENABLE US TO MAKE COMPARISONS AND CALCULATE THE NUMBER OF EXPECTED CASES

Indicators are a measure that can be used to help describe a situation that exists and to measure changes or trends over a period of time. Most health indicators are quantitative in nature but some are more qualitative.

The DHMT needs to use health indicators to analyse the district's commitment to policies for socioeconomic development and PHC, to monitor progress in implementing health programmes, and to evaluate their impact on the health status of the population. **Health indicators** are necessary in order to:

- Analyse the present situation.
- Make comparisons.
- Measure changes over time.

Indicators provide a means of comparing different districts in the country and measuring their progress in raising health status. Indicators can bring out the difference in health status between particular subgroups in the population, such as the privileged and the poor, or between rural and urban areas. Health and nutritional indicators are also indirect measures of overall development and direct indicators of the quality of life. In fact, development planners and economists are increasingly using social and health status indicators as a guide to monitor progress with different development strategies.

HEALTH STATUS IS AN INDICATOR OF DEVELOPMENT

Health indicators may measure the actual situation directly or they may be used as indirect measures. For instance, the infant mortality rate (IMR) is a direct measure of the actual risk of infants dying in their first year of life, but the IMR is also used as an indirect measure of overall socioeconomic development.

However useful an indicator may be, there are technical and financial problems in collecting the necessary data. But how accurate and valid do the data have to be for the indicator to be useful? This varies with the indicator and how it is going to be used. For analysing the present situation and for making many comparisons, indicators for use in policy-making and health programme management do not need to be highly accurate. For instance, it is usually sufficient to know that the IMR is between 40 and 60 per 1000 live births or 100 and 120 per 1000, or over 150 per 1000.

However, when **measuring changes** in health status over relatively short periods of time, such as five years, much greater accuracy is required. For instance, the IMR needs to be very carefully

calculated if it is to be used as a measure of the improvement in the district's health status. In these situations, a trend over some time is the best indication that the situation is either improving, deteriorating or remaining unchanged.

Information for calculating these indicators comes from:

- Registration of births, deaths and diseases.
- Population censuses.
- Routine health information systems.
- Surveillance.
- Investigation of epidemics.
- Sample surveys.

2.9 *Types of indicators*

It is useful for the DHMT to classify health indicators into those for:

- Health policies.
- Social and economic development.
- District population.
- Provision of health care.
- Health status.

The use of **health policy** indicators may involve a considerable degree of judgement by the DHMT, as they are difficult to quantify at the district level. They include such indicators as the level of political commitment to PHC and the availability of a public policy statement and written health plans; the allocation of manpower and financial resources from the total district resources available; the degree of equity in the distribution of resources and facilities throughout the district; the availability of a decentralized organization in the district for health planning and management; mechanisms for community participation; the degree of intersectoral coordination; and the amount of collaboration between government and nongovernment health organizations.

Social and economic indicators are useful in analysing the underlying situations that affect health. This group includes such indicators as level and distribution of economic wealth; types and levels of employment; school enrolment and adult literacy; availability of reasonable housing and number of people per room; and availability and distribution of food supplies by household and by season.

Population indicators cover such factors as age-sex structure, density, distribution and migration. Other indicators are concerned

with population growth, such as birth and death rates, fertility and rate of natural increase.

Indicators on the **provision of health care** are concerned mainly with access to health programmes and facilities, particularly community health workers, subcentres, health centres, first referral level hospitals and coverage by the eight essential elements of PHC: health education; food supplies and proper nutrition; safe water and sanitation; maternal and child health, including family planning; immunization; prevention and control of endemic disease; appropriate treatment; and provision of essential drugs and supplies. In addition, other indicators are concerned with the available **resources**, such as the number of facilities and health workers in the district and the finances or money available for PHC.

Health status indicators are mainly concerned with nutritional status, morbidity and mortality. These are considered in more detail below.

2.10 Health status indicators

The most useful indicators of health status can be grouped in three categories:

- Nutritional status.
- Morbidity.
- Mortality.

Nutritional status can be estimated in several ways. The percentage of newborn babies who have a low birth weight (LBW)—less than 2500 grams—is widely used. Anthropometric measurements, such as weight-for-age, height-for-age, weight-for-height and mid-upper-arm circumference are also commonly used for assessing nutritional status of infants and young children. Health status is indicated by the percentage of children who are classified as suffering from mild, moderate and severe malnutrition.

Morbidity indicators are generally based on the disease-specific incidence or prevalence rates for the common and severe diseases, such as malaria, diarrhoea or leprosy. A simple method for assessing morbidity is to analyse the pattern for all ages together and to derive the ten commonest causes of ill health. A more accurate method is to analyse each major age group separately.

Mortality indicators are, mainly, the crude mortality rate for all ages, infant mortality, 1-4-year old child mortality, maternal mortality, the expectation of life at birth and the disease-specific mortality rates.

More details on these health status indicators are given in Chapter 3 on the district population and in Chapter 4 on epidemiological

health information. The use of health indicators in district health planning, management and evaluation is considered in more detail in Chapter 13. More details on definitions and the meaning of the different terms are given in Chapter 14.

A list of basic health status indicators might be the following:

- Fertility rate.
- Nutritional status.
- Infant mortality rate.
- 1-4-year-old mortality rate.
- Maternal mortality rate.
- Life expectancy at birth.

CHAPTER 3
District Population

3.1 *Total population*

Most developing countries perform a nationwide **population census** about once every 10 years. The information is collected by enumerators visiting every known household in small enumeration areas and asking about all people living in the household on a particular day. The figures for each area are added together to give a total figure for the district, which commonly has a population of between 100 000 and 300 000 people. The district figures are further aggregated to give the national figures, which are then published as census reports. These reports and the district figures are usually available at government offices at the district headquarters.

A typical population distribution according to age group for a developing country is shown in Table 3.1; the actual percentage figures should be available for most countries. Infants under 1 year old (0-11 months) commonly make up 3-4% of the total population in many developing countries; children aged 0-4 years about 18-20% (one-fifth); and those aged 0-14 years about 40-44% (two-fifths). Women in the fertile age range (15-44 years) account for about 20-22% (again one-fifth). Fertile women and young children under 5 years, therefore, make up about 40%, or two-fifths, of the total population. Such national percentage figures can be used to find the approximate total number of people in the main age groups in the district.

The age-sex structure for the total population can also be shown by a **population pyramid** (see Figure 3.1), using the percentage of males and females in each 5-year age group. The age-sex breakdown may vary in different areas. For instance, there tend to be more working

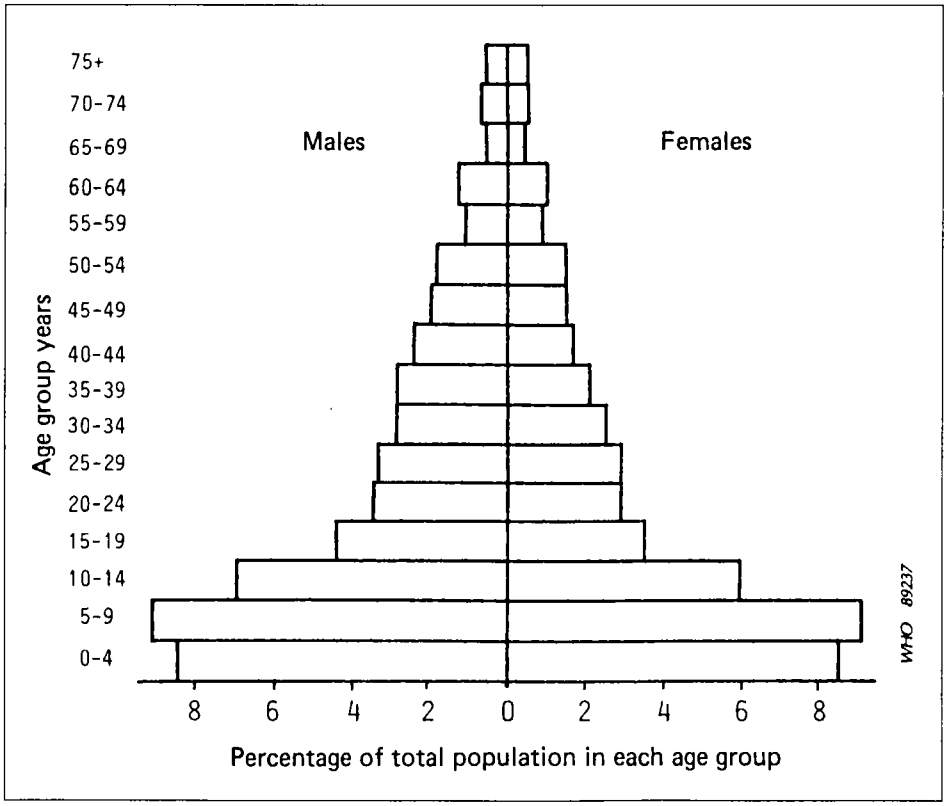
men in towns, near mines and on plantations, and where there is considerable rural-to-urban migration by men, the villages tend to have a higher proportion of older people, women and children.

Table 3.1. Typical distribution of population by age group for a district of a developing country

Age group (years)	*Percentage*	*District population*
Less than 1	4	8 000
1-4	14	28 000
5-14	26	52 000
15-44	43	86 000
45+	13	26 000
Total	100	200 000

In districts where there are marked ethnic or tribal differences it can also be important to know the percentage of each in the different age groups, particularly as the utilization of health services may be different for each ethnic or tribal group. For example, the immunization coverage might be very different between two different ethnic groups.

Figure 3.1. Population pyramid for Bangladesh
(based on the 1979 national census)



The information contained in a population pyramid is useful for providing an estimate of the denominators (the at-risk population) necessary for calculating certain age- and sex-specific rates. For example, Figure 3.1 shows that the combined percentage of male and female children aged 0-4 years is about 17% and the percentage of women in the fertile age range is about 15.5%. This latter percentage is slightly lower than might be expected, but the shape of the female half of the pyramid suggests that there was some under-enumeration of young females in the census.

IMPORTANT GROUPS IN DISTRICT POPULATION

Infants	0-11 months	1:25
Young children	0-4 years	1:5
All children	0-14 years	2:5 to 1:2
Women	15-44 years	1:5
Women and young children		2:5

3.2 Population density

This is commonly expressed as the average number of persons per square kilometre (km^2). The density can vary markedly between different districts and even within districts. Density tends to be higher in areas with large towns, fertile soil, and more advanced development. Migration can be an important factor in areas with rapidly increasing or decreasing population density. Some districts will have densities of over 1000 people per km^2, particularly in Asia, whereas in Africa many districts have fewer than 50 people per km^2.

A knowledge of the district's population density and distribution is obviously important when planning health services, particularly for new subcentres and health centres, and in evaluating the access to and coverage of different health programmes.

3.3 Demographic rates

The **crude birth rate** (CBR) is usually estimated from the census or special demographic surveys and is given by this formula:

$$\text{CBR} = \frac{\text{total births in one year}}{\text{total midyear population (all ages, same year)}} \times 1000$$

The CBR in high-fertility countries may be around 45 births per 1000 people per year and in areas of lower fertility it may be about 20 births per 1000 per year. The rates are usually available for each district, and by applying them to the district population we can

estimate the total number of births expected per year. For example, in a district of 200 000 people with a CBR of 45 births per 1000, there would be about 9000 births per year, or about 170 per week.

$$\text{Total births} = \frac{\text{CBR}}{1000} \times \text{population} = \frac{45}{1000} \times 200\,000 = 9000 \text{ per year}$$

If the health information system reports that about 80 births per week are attended by trained health workers, the coverage can be estimated to be about 50%. How well is the district doing?

The **fertility rate** (FR) is an age-sex specific rate usually derived from the census or special demographic surveys. This rate is a measure of how frequently women in the fertile age range (15-44 years) are having babies, so where the CBR is high the FR will also be high. Developing country populations with an average fertility might have a rate of about 100-150 births per 1000 women aged 15-44 years per year; in high-fertility populations it might be around 200 per 1000 and in a population with lower fertility it might be about 60 per 1000.

The **crude death rate** (CDR) is calculated as :

$$\text{CDR} = \frac{\text{total deaths in one year}}{\text{total midyear population (all ages, same year)}} \times 1000$$

The CDR commonly ranges from around 10 deaths per 1000 people per year in more developed areas to more than 20 deaths per 1000 per year in poorer populations.

The **infant mortality rate** (IMR)—which is the proportion of all liveborn infants who die in the first twelve months of life—is commonly considered a good measure of health status. It is usually calculated from the census or special demographic surveys. There are many technical problems in calculating accurate IMRs and health workers should not rely on the accuracy of their estimates unless there is a very good vital registration system in operation. The following formula is commonly used:

$$\text{IMR} = \frac{\text{total infant (aged <1 year) deaths during one year}}{\text{total births in same year}} \times 1000$$

In many poor populations in developing countries, the IMR often ranges between 60 and 150 infant deaths per 1000 births per year, but in severe conditions it may go as high as 200 or more. The district IMR is an average figure and the actual figures are frequently higher in some poor, disadvantaged groups and lower in richer groups. Most of the infant deaths occur during the first month of life; these deaths are called **neonatal mortality**. The total number of infant deaths can be calculated as follows:

$$\text{No. of infant deaths} = \frac{\text{IMR}}{1000} \times \text{no. of births}$$

Thus, in a district with a population of 200 000, 9000 births per year and an IMR of 100, the number of infant deaths would be:

$$\frac{100}{1000} \times 9000 = 900 \text{ per year, or approximately 17 per week}$$

The **child mortality rate** (CMR) is based on deaths between 1 and 4 years of age and is important because malnutrition and infectious diseases are common in this age group. It is usually calculated from a census or special surveys since it is not easily calculated with sufficient accuracy from district health information.

A neglected death rate is the **maternal mortality rate** (MMR), partly because it is difficult to calculate accurately. An approximate rate for many developing countries is 1-5 maternal deaths per 1000 births per year, which means that a district with a population of 200 000 and a CBR of 40 per 1000 might expect between 8 and 40 maternal deaths per year. In this case it is more important to know the true numbers than the rate, since the actual numbers are so small. The use of births as the denominator, instead of the number of women of child-bearing age, may give the impression that the problem of maternal deaths in developing countries is less serious than it is in reality. For example, even the fact that MMR may be 5 per 1000 in Africa compared to 5 per 100 000 in Europe does not adequately reflect the much greater risk of mothers dying from pregnancy-related causes in Africa. This is because the average number of births per woman is also much higher in Africa and therefore the risk of a particular woman dying of pregnancy complications is today about 400 times greater in many developing countries than in developed areas.

$$\text{MMR} = \frac{\text{maternal pregnancy-related deaths in one year}}{\text{total births in same year}} \times \text{factor}$$

The factor is usually 1000 or 100 000.

FOR A DISTRICT OF 200 000 PEOPLE THE FOLLOWING RATES AND TOTALS MIGHT BE EXPECTED:

CBR	20-45 per 1000	or	80-170 live births per week
CDR	10-20 per 1000	or	40-80 all deaths per week
MR	60-150 per 100	or	5-25 infant deaths per weeks
MMR	1-5 per 1000	or	1-3 maternal deaths per month

3.4 Population growth

The **population growth** in a district depends on the balance between the number of births and people migrating into the district on the one hand, and the number of deaths and people migrating out on the other. Occasionally, a district's population may actually be declining, but this is usually due to migration away from the area, and not because deaths outnumber births.

The **rate of natural increase**, which excludes migration, is commonly between 1% and 3% per year in many developing countries and is calculated as follows:

Rate of natural increase = CBR minus CDR

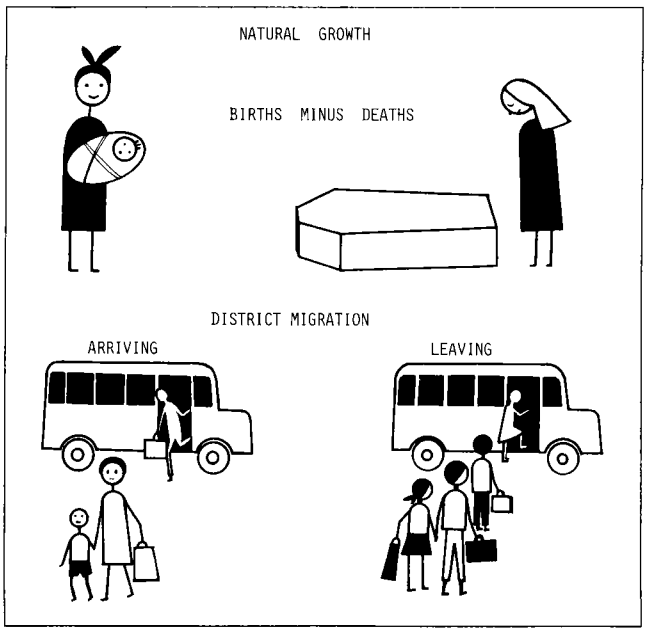
This rate largely determines how fast the district population will grow, as shown in Table 3.2.

Table 3.2. Natural growth in the district population

Rate of natural increase	*Present district population*	*Population increase in 10 years*		*Population increase in 20 years*	
		total	*% increase*	*total*	*% increase*
1%	200 000	220 900	10	244 000	22
2%	200 000	243 800	22	297 200	49
3%	200 000	268 800	34	361 200	81

Figures calculated to nearest 100 people and percentages to nearest whole number.

Figure 3.2. Growth in district population due to natural growth and migration



Besides the rate of natural increase in population, the number of people migrating into or out of the district must also be taken into account. This number will probably have to be estimated, as accurate figures on migration are not usually available. Some estimates may be available from the last census, but for most districts you will probably have to rely on local knowledge.

WITH 3% NATURAL GROWTH THE POPULATION WILL DOUBLE IN 25 YEARS

Estimates of population growth can be derived from the size of the population at two or more points in time. The simplest way of estimating population growth is to obtain the difference between the population size at two points in time and then to divide this difference by the number of years' interval between them. This yields the average growth in the number of persons per year.

Example: If the population in an area was estimated to be 7830 on 31 March 1985 and 8450 on 30 September 1989, then the average increase per year is estimated to be (8450 – 7830) divided by 4.5 = 138 people. The estimated population on 30 September 1990 is therefore 8450 + 138 = 8588.

This method assumes that the increase in the number of people per year is constant. However, when used for projections over a longer period of time, this method tends progressively to underestimate the total population, as populations tend to grow at a constant rate of growth rather than by a constant absolute increase per year (as illustrated in Table 3.2).

3.5 *Sources of population information*

A knowledge of the number of people living in the district, with additional information on their age, sex and geographical distribution, is necessary for several aspects of planning and evaluation of health services. DHMTs will need **population estimates** for the district to provide:

- Total population by age and sex groups and other relevant criteria.
- Total number of expected live births and deaths per year.

The published sources for such information are:

Reports on the census. If a population census has been taken recently and the data for the area in question are available, the census report can be invaluable. Often the information is not readily available on a local area basis and other ways to obtain it will have to be explored.

Reports of other studies. A study carried out by somebody else in your district may yield useful population data that can be useful. For example, there may have been an agricultural or economic survey in the area, or a survey in connection with social research. There may also have been studies previously carried out by other health authorities or research organizations. Extensive mapping and census data are often collected for malaria and other large-scale disease control programmes.

Other sources. Other possible sources of information are the authorities concerned with the provision of other services in the area, for example, housing, education, law enforcement and public utilities. Valuable information may be obtained from socioeconomic development schemes carried out by sectors other than health, e.g. ministries of agriculture, water, labour, social welfare and rural development. Religious organizations are often well informed and may have properly documented data.

Assistance may be sought from senior officers in the medical and health services, and from research personnel and demographers or statisticians in the government and in universities. It is possible that similar requests for assistance may have been received from other parts of the country, and a programme might then be drawn up at a central or regional level for obtaining more population data or for updating old information.

If the required population data cannot be found from any of the sources previously mentioned, then the health team may have to obtain them directly or rely on the best estimates available.

Two quick ways of estimating small local populations are:

- To ask all local leaders how many people they are responsible for and to add all the responses to obtain a total. However, beware of being misled for various reasons, such as fear of taxation.
- Ask for the total number of houses, or count them, and multiply by the known average household size for your district. If the average is not known a useful method is to visit every 10th or 20th household and ask for details on all the people who normally live there. Visit between 100 and 150 households. The average is commonly around five people per household in many developing countries in rural areas. It may be lower or higher for urban households.

3.6 *Accuracy of data*

When considering how to obtain the necessary data, it would be wise to keep in mind that the accuracy of population data is limited, not only by the resources available for their collection, but also by the level of socioeconomic development and the educational and cultural sophistication of the population itself. Because of the numerous factors that can contribute to inaccuracies in population data, it is very important to have built-in mechanisms for validating various important items of information. For example, to elicit information on the number of children a mother has had, a common method is to obtain the birth order of all her children, starting with the first born, and ask about pregnancies in the long gaps; a pregnancy about every two years is a frequent pattern in many countries.

How accurate and complete population data must be before they can be useful depends on the purpose to which they are to be put. Sometimes even very rough estimates may be good enough and resources would be wasted on efforts to obtain more accurate data. In any case, data are rarely useless simply because they are not absolutely accurate.

In general, the more developed the medical and health services are, the greater will be the need for detailed and accurate data for planning and evaluation. However, in such services, it will also be easier to obtain more accurate data.

The target in terms of accuracy can never be 100%. However desirable it may seem to be, it is in practice neither possible nor necessary to attain this degree of accuracy. In practice the aim should be to obtain:

- Data that are as accurate as reasonably possible, given the resources available.
- An estimate of the nature and extent of inaccuracies in the data. It is as important to try to estimate what inaccuracies are present as it is to try to obtain data as accurately as possible.

To improve the accuracy of the information on various population characteristics, it will be helpful to consider the following particular examples.

Age

Age is a basic variable that is particularly required, as it is closely related to disease patterns. It may also be one of the most difficult variables to ascertain accurately. Although people often do not know their age in years, they may know in which year they were born. Hence it may be worthwhile to ask both questions and see which gives the most reliable answers.

In situations where birth records are not kept, age can sometimes be estimated according to a calendar of notable events that occurred in the community. In such a situation, for example, a person's age might be estimated by asking:

"How many seasons after the earthquake were you born?"

A more precise method of estimating age in the younger age groups is usually required. For those in the age range of 6-24 months, age can be crudely estimated from the following formula, provided the child has not suffered from severe malnutrition:

Age (in months) = 6 + number of erupted teeth

A considerable proportion of people will give different ages on separate occasions. For instance, it was found that 43% of those enumerated in Ghana in 1960 by two interviews were classified in different five-year age groups, older age groups being more inaccurate

than younger ones. One form of age error, which is very widespread, is a tendency to round off ages and say one is 30 or 40. Sometimes men wish to seem older as this brings more prestige and to report their wives as being younger. In order to avoid the distortion of the age structure which may arise from wrong information about age, it is best to group people by five- and ten-year age intervals e.g. 0-4, 5-9, 10-14, 15-24, 25-34, 35-44, 45-54, 55-64, 65+.

Because of these inaccuracies, it is important to use strict criteria when recording age, to specify how age was calculated, and to mention the source of the information.

Sex

HOW ACCURATE ARE THE DATA?

Sex is another important characteristic to record, because of the different physiological and behavioural patterns in the two sexes. Marked differences between the sex composition of a survey population and the general population could result in the survey results not being valid. Considerable care is needed to avoid this. For example, in some countries it is a common practice for women to be secluded in their homes and interviews may be very difficult to obtain, so that women are under-enumerated in censuses.

Ethnic group

People in the same ethnic group tend to have similar social and cultural practices and some of these practices may result in either higher or lower disease frequency than in other groups. It may be important, therefore, to study different ethnic groups and to understand their particular sociocultural patterns, as this could provide clues to how disease may be reduced in the community.

Marital status

The precise definition of what is meant by a "married" or "separated" state may raise problems. Such definitions vary considerably. Often such distinctions in marital status do not play as important a social role as in traditional western society. A thorough understanding of the population and of its customs and life-styles is thus important, for it will help in deciding whether or not to include such variables in the study.

Occupation

In obtaining information about the person's occupational status, decide whether present or past occupations are to be recorded. For example, a person who has recently started his or her present job may have worked for the previous 10 years in a totally different occupation. It may be more useful to record the occupation in which the person has spent the longest time, as well as his or her present one. A worker might have spent the past 15 years working in a granite stone quarry, but as a result of pulmonary silicosis was unable to continue and recently obtained employment as a watchman.

If the records show only his present employment, it will be difficult to understand how a watchman contracted silicosis. Changes in occupation from one season to another are also common in rural areas. Some villagers may farm during the rainy season and fish after the harvest. The possibility of exposure to more than one risk must, therefore, be kept in mind.

Other variables

Data on other variables such as parity, religion, social class, place of residence and mobility may be required. For census and registration systems, nomads can pose difficulties. Village heads rarely know the whereabouts of all the nomads from their villages. A problem encountered in some parts of Africa is that the men leave their camps early in the morning to look after cattle and the women are not permitted to mention their husbands' names. These examples show it is necessary to adapt methods of collecting information to the local context.

3.7 *An example: the Malumfashi Endemic Diseases Project*

In this project on endemic disease in Nigeria, maps were required before census enumeration could be done. Because of the inadequacy of existing maps, basic maps at a scale of 1:20 000 were drawn, based on recent air photography. These maps were then checked in the field when the households were assigned numbers; compounds that had been omitted on the base map were added and those that had been abandoned were deleted. Such maps were adequate for scattered settlements, whereas new large-scale plans were drawn for densely populated settlements.

The enumeration questionnaire used in Malumfashi was similar to that used at Machakos in Kenya, which was a modified version of the form designed for the 1969 Uganda census. The first half of the enumeration questionnaire used at Malumfashi asked for such basic information as age, sex, and residence. The second half consisted of more detailed questions on survivorship, fertility and mortality. The main sections of the questionnaire were as follows:

- Each individual was identified by name, a survey number and the geographical location. The construction of individual survey numbers intentionally contained the location so that the number alone provided a guide as to where the individual was resident.
- Data were collected on residence. For demographic purposes it was essential to distinguish between residents and visitors when defining the population. Enumeration was carried out over some months, and a de jure definition of population was used, i.e. based on a population that comprises all persons who usually reside in the defined area.

- The date of birth and sex of each individual were noted. It was intended that the date of birth should be accurate to the month for children under 5 years old and accurate to the year from age 5 years onwards.
- Cultural group and stated religion were recorded.
- Marital status was noted for each individual.
- Questions were asked on the survivorship of parents, first spouses and oldest siblings, and deaths in the household during the previous 12 months were recorded, to provide estimates of mortality.
- Each female aged 15 years or over was asked questions about the number of births she had had, and also about her most recent live birth and whether the child had survived or not. Fertility rates and infant and child mortality rates were computed from this information.

3.8 *District population checklist*

- Obtain or draw a large-scale map of the district and mark on it all health facilities and large villages.
- Determine the present total population for the district and its density in different areas.
- Assess migration patterns and estimate the annual district growth rate from official published figures.
- Calculate the total number of people in the 0-11 months and 1-4, 5-14, 15-44 and 45+ years age groups and the total number of women aged 15-44 years.
- Obtain the official district figures for the crude birth rate, crude death rate, infant mortality rate and maternal mortality rate.
- Work out the expected total number of births and deaths per week and per year for the district. Do this for all deaths, as well as infant, child and maternal deaths separately.

CHAPTER 4
Epidemiological Health Information

4.1 *Health status assessment*

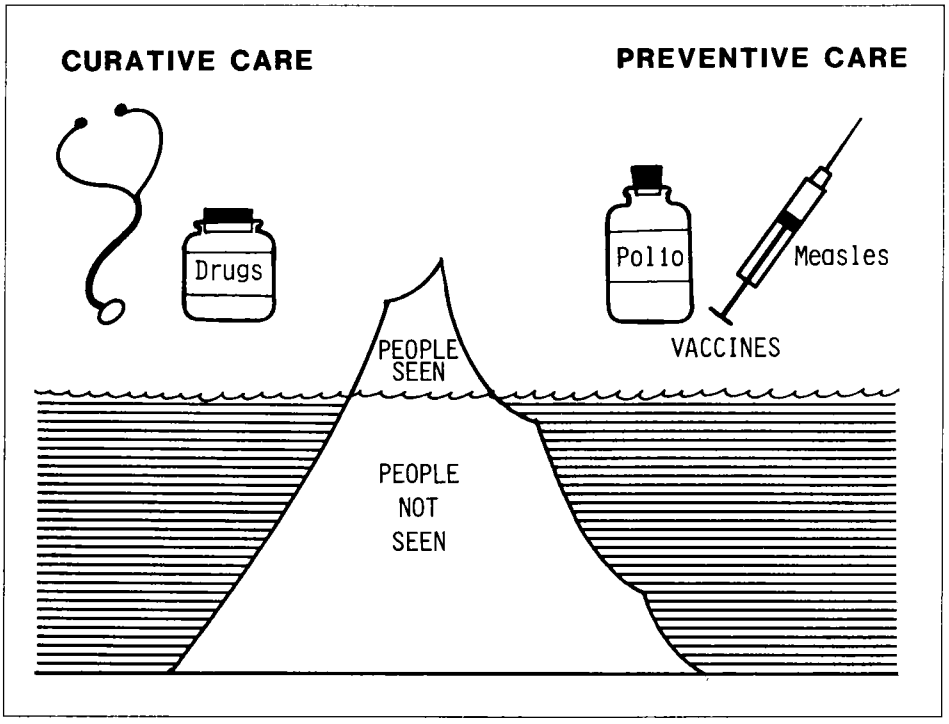
An assessment of the health status of the community, based on information about health problems and diseases, is necessary for planning and evaluating the health services. However, since the cost of obtaining such information, in terms of resources and time, can be considerable, it is very important that the DHMT selects the data that are most feasible to collect and that will be most useful for its work in the district. In addition to this information, the DHMT will also need information on the health resources of the district and how they are being used. The use of this information in district health planning and management is dealt with further in Chapter 13.

Useful information on health status can often be obtained fairly easily from the information reported to the district headquarters. This information can be made of greater value, not by a detailed or elaborate analysis, but by looking at it in its proper context. For example, if in a reported outbreak of a dozen cases of jaundice there have been two or three deaths, this indicates immediately that the problem may be yellow fever and not hepatitis. Similarly, a general increase in reported episodes of diarrhoea in older children and adults may be the start of a cholera outbreak. District health workers are in the best position to put such locally collected information into its proper context.

Each country, region and district will have to decide on the specific items of information required for planning, management and evaluation of its health services. Each type of information has its uses and limitations. A useful concept is that of the "iceberg phenomenon", which emphasizes that the mass of health problems lies below the surface and is frequently not fully recognized (see Figure 4.1).

In most countries a **routine health information system** already exists, but health workers may have to take the time to uncover and analyse the "hidden" data it contains. This system will provide useful information or at least a good "guestimate". Make the best use of the data being collected, rather than rejecting it as unsuitable. On the other hand, the collection of useless and unnecessarily complicated data should definitely be discouraged.

Figure 4.1. The iceberg phenomenon—routine information comes mainly from people who attend the health services



4.2 *Important diseases*

Which are the important diseases? From an epidemiological viewpoint there are two factors that are indicative:

- Frequency—high incidence or prevalence, including potentially epidemic diseases.
- Severity—causing much disability and a high mortality.

IMPORTANT AND CONTROLLABLE DISEASES SHOULD HAVE THE HIGHEST PRIORITY

For example, falciparum malaria is important because it can have a high incidence and lead to many deaths. Similarly, malnutrition can have a high prevalence and a high mortality. Some diseases are important because they are potentially epidemic, such as cholera, meningococcal meningitis and trypanosomiasis. Many outpatient attendances are for minor self-healing illnesses and, although they are important to the individual, they are not particularly important to the community as a whole.

Diseases that have a high frequency and are severe, and which are preventable or controllable, should receive the highest priority in planning health programmes.

4.3 Sources of epidemiological information

The routine district health information system commonly has information on the frequency and distribution of the locally important causes of morbidity and mortality. However, often this information is not presented in a way that is easy to understand and use.

Morbidity information gives the overall picture of ill health in the community. Although this information is often deficient in quality and quantity in developing countries, the district sources include the following:

- Hospital inpatient records
- Outpatient records
- Disease notifications
- Workplace records
- Schools
- Special surveys

Hospital inpatient records

Analysis of hospital and clinic records can provide high-quality information on the most important causes of major illness in a community, but for them to be useful as an indicator of the health status of the whole population, allowance must be made for the strong tendency for inpatients to come from among people living near the hospital, the wealthier and the better educated. In some countries, many seriously ill patients never reach a hospital if they live far away.

Outpatient clinic records

Records of people attending health centres and health posts as outpatients may provide information, but there are problems in collecting the necessary data. For example, diagnoses are frequently given in terms of the chief complaint or symptoms; attendances are given in terms of total visits rather than by new and repeat visits; and people attending for immunizations or other preventive services may be recorded together with those who have come because they are ill. The information suffers from selection biases similar to those

mentioned for hospital records. Although health centres and health posts may cover a wider population than hospitals, patients who live near a facility and who can afford the time and fees, if any, are the people most likely to attend. Such records, however, do provide information about the use made of outpatient facilities and the most frequent complaints, and do help to describe the pattern of disease in a community.

Disease notifications

Notification systems are restricted to a selected list of "important diseases", which may differ from one country to another. By and large, these diseases are the infectious ones which require prompt action for control. Medical practitioners and other health personnel may have a special responsibility and may be legally required to provide such notifications. The health officer in charge of the district is usually responsible for receiving the notifications and taking the most appropriate action.

Workplaces and schools

Workplaces may provide data on absences due to sickness as well as the results of any periodic health examinations. Data on those employed reflect the situation in a selected sample of people who work; people who are ill may not have been employed in the first place, or they may have had to leave employment because of ill health.

Schools can provide data on absences due to sickness as well as the results of screening programmes by school health services. In countries where school attendance is low the information may be substantially biased and likely to miss those children who are socially and economically disadvantaged.

Special surveys

There are two ways in which important diseases may be underrecognized by district information systems. If the disease has a low frequency (incidence or prevalence) there may be too few cases for them to show up clearly in a poorly functioning health information system—leprosy is a good example. The other way is when the illness does not produce clear symptoms and signs that are easily recognized by the people themselves or the health workers. Schistosomiasis, filariasis and malnutrition are good examples.

Special surveys and research studies are often required in these circumstances, particularly for subclinical and chronic infections such as malaria, African trypanosomiasis, Chagas disease, filariasis, leprosy and schistosomiasis. The same applies to chronic physical and mental disabilities and eye diseases. The importance of poliomyelitis and neonatal tetanus in many developing countries was demonstrated mainly by such special surveys.

4.4 Morbidity patterns

ROUTINE INFORMATION SYSTEMS MAINLY REPORT COMMON AND EASILY RECOGNIZED DISEASES

Because of the high infant and childhood morbidity rates and the high percentage of children in developing country populations, a high proportion of the total illness (up to 50%) occurs in the younger age groups. This means that a great deal of outpatient and inpatient work at hospitals, health centres and health posts will be concerned with children.

The most readily available source of data on serious morbidity is hospital records, but, as indicated above, due caution is needed in interpreting such data. For instance, in malarious areas, malaria and diarrhoeal disease alone often account for about a quarter of all outpatient attentances. The ten most frequent causes of admission to hospital are shown below for the United Republic of Tanzania. This list can be considered fairly typical for a developing country. It should be noted that:

- A fifth of all admissions are for pregnancy, its complications and the delivery of babies.
- A fifth to a quarter of all admissions are for common diseases such as malaria, pneumonia and diarrhoeas.
- Measles is frequently among the first ten causes of admission.

Table 4.1. Hospital-reported morbidity for the United Republic of Tanzania

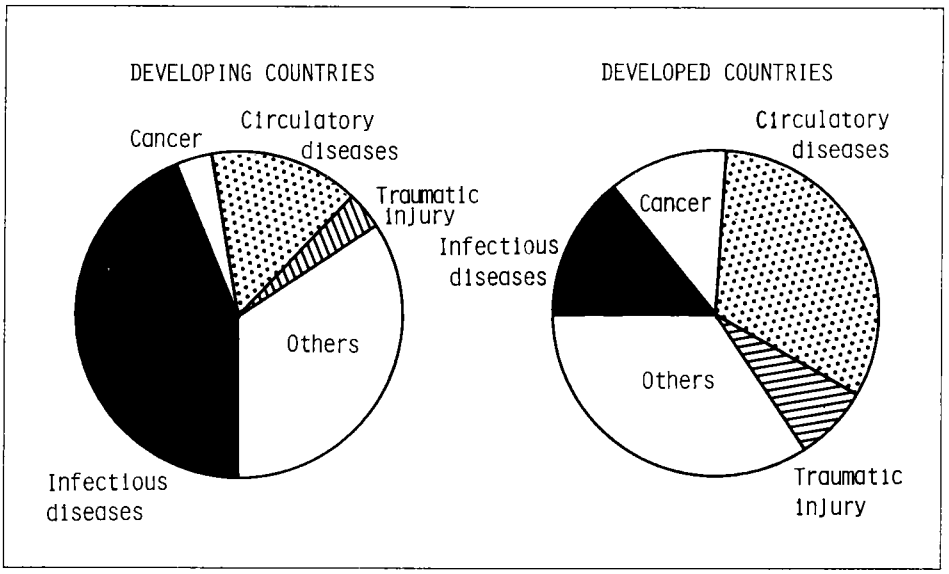
	Causes of hospital admission	*% of total admissions*
1.	Deliveries, complications of pregnancy, childbirth and puerperium	22
2.	Malaria	8
3.	Pneumonia	7
4.	Diarrhoea	7
5.	Anaemia	6
6.	Measles	4
7.	Hookworm	3
8.	Bronchitis, emphysema and asthma	2
9.	External injury	2
10.	Ascariasis	1
	Total	62
	All other causes	38

TEN CONDITIONS ARE COMMONLY RESPONSIBLE FOR ABOUT TWO-THIRDS OF ALL ADMISSIONS TO HOSPITALS

4.5 Mortality patterns

The main causes of mortality are different in developing and developed countries, as shown in Figure 4.2. These pie charts show that the infectious diseases and "other" causes, which include malnutrition, account for three-quarters of all deaths in developing countries, whereas cancers, circulatory disorders and traumatic injuries account for over half of the deaths in developed countries.

Figure 4.2. Distribution of the causes of death in developing and developed countries



In countries without an effective system for registering deaths and certifying the causes, information on mortality patterns is largely based on deaths occurring at health facilities, despite the recognition that these deaths are a selected sample. Some countries have designated sample population areas which are kept under surveillance for vital events such as births and deaths. However, classifying deaths that occur in the community by cause requires the details to be gathered retrospectively from relatives. This is not an accurate way to certify the cause of death, although "verbal autopsies" by doctors can be helpful. Accurate information on deaths often has to be collected by special demographic and health interview surveys.

Mortality data are based on **death registration** (number and distribution) and **death certification** (cause). In many developing countries a large proportion of deaths are unregistered and death certification, often of doubtful accuracy, is generally limited to patients who have been admitted to hospital. Frequently, only about 10-20% of deaths

are certified by cause, and many of these registered deaths will be of urban middle-aged adults who were relatively well-off. There is commonly an under-representation of rural people, infants, the elderly and the poor. Despite these faults, however, such information does provide some idea of the major causes of death. The information is rarely available on a district level and the DHMT will often have to make its own estimates for the district population. A further difficulty in using death certificates is the quality of the information on the underlying cause of death, which is often poorly and inaccurately entered by medical officers (see Section 4.8).

IN MANY DEVELOPING COUNTRIES 40-50% OF ALL DEATHS OCCUR IN CHILDREN

In some countries special samples in the national census are used to provide age- and sex-specific death rates, sometimes by state or region. These rates are likely to be far more accurate than those based on death registration, but they usually provide no information concerning the causes of death.

Table 4.2 shows a list of the ten most common causes of death in hospital in the United Republic of Tanzania. This list may be considered typical for developing countries. It is clear that:

- Pneumonia, measles and diarrhoea, particularly in children, account for about a quarter to a third of all hospital deaths.
- Chronic conditions such as malnutrition, tuberculosis, heart disease and anaemia are also very important causes of death.

Table 4.2. Common causes of death in hospitals in the United Republic of Tanzania

Diseases		*% of total deaths*
1.	Pneumonia	16
2.	Measles	11
3.	Diarrhoea	10
4.	Conditions of early infancy	7
5.	Malnutrition	5
6.	Tuberculosis	5
7.	Tetanus	4
8.	Heart disease	4
9.	Malaria	4
10.	Anaemia	3
	Total for 1-10	69
	All other causes	31

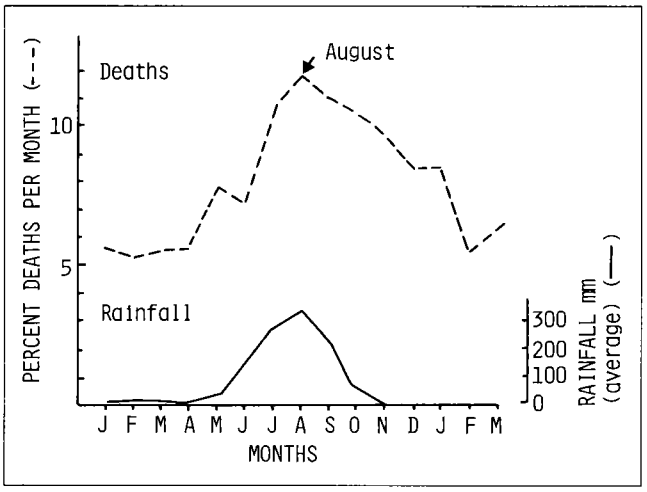
4.6 Seasonality

In many developing countries health programmes are more difficult to organize during certain months or seasons. However, what is not so well appreciated is that disease frequency, health behaviour and use of health services also show considerable **seasonal variation** or **seasonality**.

SEASONALITY AFFECTS MORBIDITY, MORTALITY AND USE OF HEALTH SERVICES

Seasons are accompanied by marked climatic changes, all of which affect household and agricultural activities, including the availability of paid work. Seasonality particularly affects the urban poor and the rural subsistence farmers, who are vulnerable because of their low family income and the seasonal availability of food supplies. Malnutrition is, therefore, frequently more common at certain times of the year. The insect vectors of some communicable diseases, such as the mosquitos transmitting dengue, filariasis and malaria, begin to increase with the onset of the rainy seasons. During the colder months people tend to crowd together, which promotes the spread of airborne and contact infections, such as respiratory diseases and measles. An example of a seasonal variation in mortality rate is shown in Figure 4.3.

Figure 4.3. Variation in the percentage of deaths occurring per month, showing a peak during the rainy season, largely attributable to deaths from malaria
(based on data from India)



In addition, people are less likely to use the health services during the difficult months, the supervision of community health workers and health posts will be less effective and the availability of essential drugs will probably be lower.

It is very important, therefore, for the DHMT to analyse all the available health information by month or season of the year and to take seasonality into account when making district health plans. Greater efforts may be needed during the "unhealthy" seasons.

4.7 *Using morbidity and mortality rates*

If reasonably reliable **disease-specific incidence or prevalence rates** are known for the district, or national ones are available, it is possible to calculate the approximate number of cases that the district might expect in one year. This applies particularly to chronic diseases such as leprosy and tuberculosis, whereas acute diseases are liable to show too much seasonal or annual fluctuation in incidence for these rates to be particularly useful at the district level. Although the number of cases derived from known rates may not be very accurate, the information is sufficient for most health planning, management and evaluation purposes.

For instance, if the prevalence of pulmonary tuberculosis is stated to be 5 per 1000, then there should be about 1000 cases on the register in a district population of 200 000, as follows:

$$\text{No. of tuberculosis cases} = \text{prevalence rate} \times 200\,000$$
$$= \frac{5}{1000} \times 200\,000$$
$$= 1000 \text{ per year}$$

THE EXPECTED NUMBER OF CASES CAN BE CALCULATED USING RELIABLE RATES

If there are only 250 patients on the register, the health services are treating only about a quarter of all pulmonary tuberculosis cases in the district. This then raises the question: How effective are the services? The example also demonstrates why it may be dangerous to rely on incidence or prevalence rates calculated from cases reported by the district's routine information systems.

Disease-specific mortality rates for the district population are difficult to calculate with any reasonable degree of accuracy, but in the planning of health programmes against chronic diseases, national or other reliable rates can be used to calculate the number of expected cases. A good knowledge of the expected total number of deaths is useful for certain epidemic diseases, such as cholera, typhoid, meningitis, typhus and African trypanosomiasis. A small increase in the total number of cases or deaths may signify that an undetected epidemic is already under way in the district.

A measure of disease severity is the **case fatality rate**, usually expressed as a percentage, as follows:

$$\text{Case fatality rate} = \frac{\text{number of patients dying from a disease}}{\text{number of cases of the disease diagnosed in same period}} \times 100$$

CASE-FATALITY RATES CAN MEASURE DISEASE SEVERITY AND QUALITY OF MEDICAL CARE

This rate can also be used as a measure of the quality of the treatment being given by the medical services. For instance, if a hospital admits 200 cases of malaria in one year and 30 die, the hospital case-fatality rate is 15%, which might be considered too high. However, interpretation of this figure must also take into account the mixture of cases on admission, that is, how many were mildly ill and how many severely ill.

It is also useful to calculate the fatality rate for cases arising in an epidemic, as it gives a clear indication of the severity of the illness and can point to which disease is causing the epidemic.

4.8 Death registration and certification

Death registration is the official recording of a person's death and usually includes name, age and sex of the person, and the date of death. In most countries it is a legal requirement, but it is often not enforced and frequently not a responsibility of the health system. **Death certification** records the cause of a person's death, as stated by a doctor or another responsible health worker. Information from death registrations can be useful in compiling mortality statistics and in the surveillance of specific diseases, particularly in countries where registration is reasonably complete. Analysis of known deaths may also be useful in evaluating disease control activities and a rise in certified deaths from a particular cause may indicate a serious outbreak.

Information on mortality has the advantage that the data tend to be more accurate than those for morbidity reporting (for such elements as diagnosis and personal data), but it has the disadvantage that only fatal cases are included.

In many developing countries, the data may be deficient because certification of deaths is not done by a doctor and there is considerable under-registration.

An outline of the **medical certificate** on the cause of death (based on recommendations by the World Health Organization) is shown opposite.

It should be noted that the certificate is in two parts. Part I shows the sequence of events leading to death and proceeds backwards from the most direct cause in I(a). This does not mean the mode of dying, e.g. heart failure. It means the actual disease, injury or complication that immediately caused the death. Then come the underlying causes. In compiling statistics, deaths are classified by **underlying cause**, which is frequently not the same as the most direct cause.

Figure 4.4. Medical certificate of the cause of death

	Cause of death	*Approximate time between onset and death*
I		
Disease or condition directly leading to death	(a)_____	_____
	due to (or as a consequence of)	
Antecedent causes	(b)_____	_____
Morbid conditions, if any, giving rise to the above cause stating the underlying condition last	due to (or as aconsequence of)	
	(c)_____	_____
II		
Other significant conditions contributing to the death, but not related to the disease or condition causing it	_____	

4.9 *District health information checklist*

- Review of the collection and analysis of basic data:
  - symptoms and diseases included
  - diagnostic criteria used
  - reporting by which facilities
  - reporting frequency and regularity
  - efforts made to analyse data.
- Distribution and use of information:
  - use by district health management team
  - distribution of information within district
  - feedback to health facilities
  - reporting to regional and central authorities.
- Improvement of the routine information system:
  - common and obvious faults
  - effectiveness of reporting for important items

- effects of seasonality
- more standardization of procedures
- inclusion of in-service training for primary health care workers.

- Presentation of epidemiological information:
  - ten commonest diseases in outpatients and inpatients
  - ten commonest causes of death in hospitals
  - distribution of common and epidemic diseases throughout district
  - importance of other health problems, such as those of pregnancy and delivery, child-spacing, nutrition, water supplies and health behaviour.
- Frequency, distribution and importance of the following diseases in the district:
  - obstetric and perinatal problems such as:

    prolonged labour, haemorrhage, retained placenta, puerperal pyrexia, respiratory and feeding difficulties in newborn, neonatal tetanus
  - common diseases such as:

    accidents and injuries, diarrhoea, intestinal helminths, leprosy, malaria, malnutrition, measles and tuberculosis
  - other locally endemic diseases such as:

    filariasis, rabies, schistosomiasis, sexually transmitted diseases, tetanus, trachoma and trypanosomiasis
  - potentially epidemic diseases such as:

    cholera, meningitis, plague, relapsing fever, typhoid, typhus and whooping cough.

CHAPTER 5
Reporting and Surveillance Systems

5.1 *Routine health information systems*

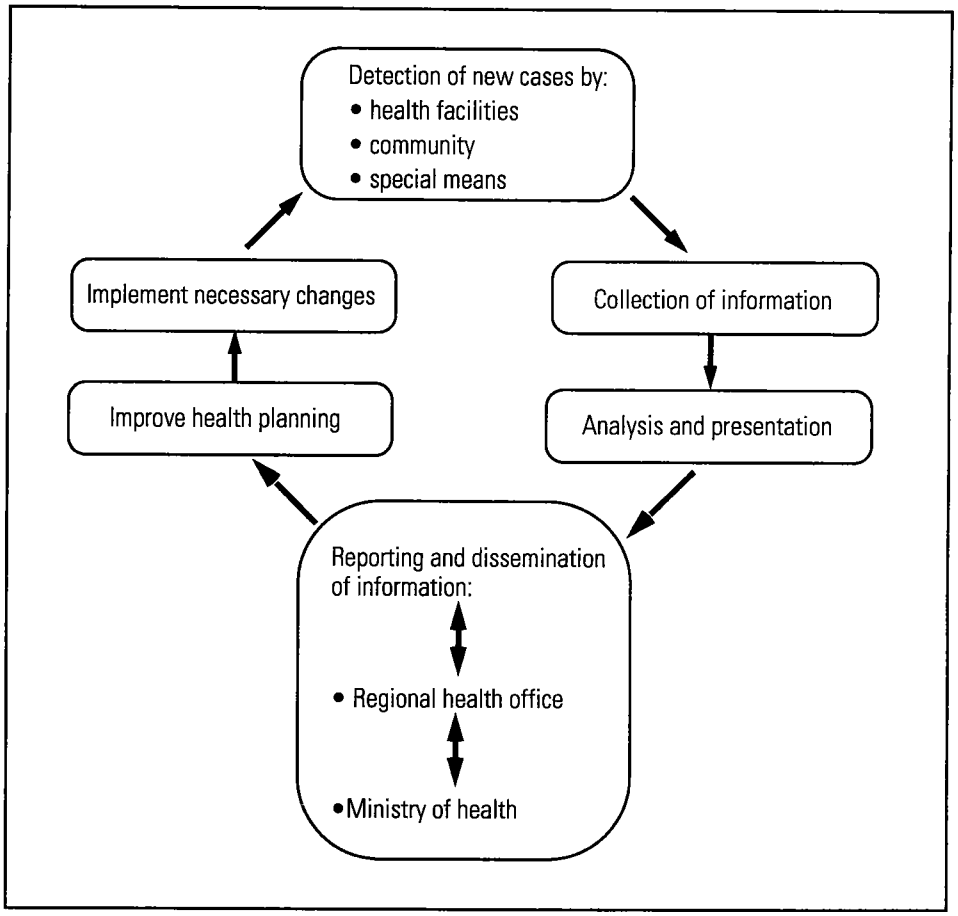
Each country will have its own system of collecting routine health information and reporting it from the periphery to the centre. District health workers need to be familiar with this system and to appreciate what is required to make it work efficiently. An outline of such a system is shown in Figure 5.1.

Information is collected when people visit the health facilities and the data are written down or recorded in various ways. The collected data are then analysed and included in reports, which may be communicated by the DHMT to health workers and to other district organizations. The national ministry of health is responsible for collating the information for the whole country.

Unfortunately the health information systems in many countries are frequently characterized by elaborate forms filled in by clerical workers in outpatient clinics and hospitals and sent for analysis at central headquarters. This analysis is often carried out many months or even years later, with no feedback to those collecting the original data. The result is data that are of limited value to the DHMT.

For the most part, district staff may have little say in the number or format of the forms to be used, but they can influence how well they are used. It is important to keep in mind that information is

Figure 5.1. Routine district health information or surveillance system



needed by virtually everyone involved in health and that the efficient and timely communication of that information is essential. Properly designed forms are necessary to accomplish this.

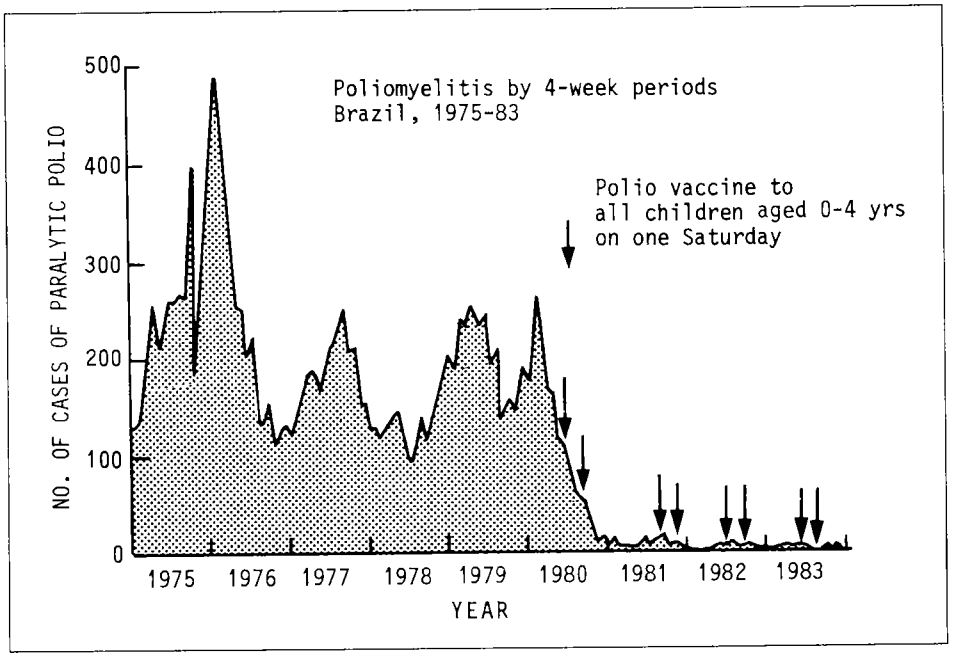
For the primary health care level, emphasis should be on collecting the minimum amount of necessary data in the simplest possible way. An important principle is that any data recorded by health workers should be useful to the workers themselves and to their supervisors in their duties. The major purpose of collecting such information should be to support the management and evaluation of the health activities being carried out at the worker's level. The DHMT is in a good position to make the best use of this health information system and to keep these principles in mind.

Controlling the quality of the collected data is of vital importance and checks will have to be made to ensure compliance with the methods laid down. One way to do this is to make certain that the forms are directly useful to the health workers and supervisors in planning and evaluating their own district health services and programmes.

Districts may participate in and use national reporting and surveillance systems, but they may also need to set up their own local system. It is important to realize that for a system to be useful it

does not have to detect all cases. Good estimates of incidence can be invaluable for planning and evaluating health programmes and, provided the proportion of cases detected remains reasonably constant, trends over time can be forecast. Incomplete data are certainly much better than none, provided that the problems and defects in the data are understood. This is well illustrated by the number of poliomyelitis cases detected in Brazil before and after the onset of a polio immunization campaign (see Figure 5.2). Even though all cases were not detected the trend suggests very strongly that the incidence of poliomyelitis has been markedly reduced since the start of the campaigns.

Figure 5.2. Decline in the incidence of paralytic poliomyelitis in Brazil following mass immunization campaigns



5.2 *Surveillance*

The term **surveillance** is used in two rather different ways. First, surveillance can mean the continuous scrutiny of the factors that determine the occurrence and distribution of disease and other conditions of ill health. It is thought to be essential for effective control and prevention, and includes the collection, analysis, interpretation, and distribution of relevant data. Such a broad definition almost equates surveillance with routine health information systems and the two can therefore be considered together.

The second use of the term refers to a special reporting system which is set up for a particularly important health problem or disease, for example the spread of communicable diseases in a natural disaster, nutritional status in a famine, or an epidemic. Such a surveillance system is often organized for a limited period and is closely

integrated with the management of a health intervention programme. It is organized when information on incidence is urgently needed but reliance cannot be placed on routine information systems. This may be because the coverage of the population by the routine reporting system is low, because the reporting is too slow, or because the system itself is faulty and cannot quickly be improved.

Districts would be wise, at least initially, to limit a new surveillance activity to diseases and problems for which there is a continuing programme, for instance an expanded programme on immunization or a specific control programme for cholera or malaria.

Surveillance aims to provide quickly information which can be analysed to determine frequency (usually incidence), and to answer the questions: who? where? and when?

Epidemiological surveillance has a number of major uses:

- To identify outbreaks and epidemics and to ensure that effective action to control the disease is being taken.
- To monitor the implementation and effectiveness of a specific control programme by comparing the extent of the problem before and after the implementation of the programme.
- To assist in the planning of health programmes by showing which health and disease problems are significant and therefore worthy of specific intervention. This also assists in deciding on priorities.
- To identify high-risk groups (e.g. by age and occupation), geographical areas where the problem is common, and variations over time (e.g. seasonal and year to year). This also assists in planning programmes.
- To increase knowledge of vectors, animal reservoirs and the modes and dynamics of transmission of communicable diseases.

Examples of events that may require surveillance are:

- Epidemic diseases, e.g. yellow fever, dengue, meningococcal meningitis.
- Nutritional status and malnutrition.
- Animal reservoirs and vectors of communicable diseases.
- Environmental pollution, particularly of water.
- Demographic events, such as births and deaths.

Three diseases (cholera, plague and yellow fever) are covered by the International Health Regulations, while a further five (epidemic typhus, influenza, malaria, poliomyelitis, and relapsing fever) are subject to global surveillance. Six diseases (filariasis, leishmaniasis, leprosy, malaria, schistosomiasis and trypanosomiasis) are included in the UNDP/World Bank/WHO Special Programme for Research

and Training in Tropical Diseases, and immunization against six other diseases (diphtheria, measles, poliomyelitis, tetanus, tuberculosis and whooping cough) is part of the WHO Expanded Programme on Immunization. Certain diseases will, of course, be of particular regional or local interest.

5.3 *Definition of cases*

The criteria for recording a particular patient or event as a case must be clearly defined and practical. The criteria for reporting a possible, probable and definite case must also be clear. With malaria, for example, should any person with a fever be reported, or only a young child with no other apparent cause of fever? Should a positive laboratory diagnosis be required as well? The criteria chosen must be realistic and easily understood. Some examples of the use of symptoms and signs for reporting possible cases of certain diseases by primary health care workers are given in Table 5.1. These are only suggested criteria, which should be modified to suit different situations.

DEFINE THE CRITERIA FOR REPORTING A CASE, AND THEN TRAIN HEALTH WORKERS TO APPLY THEM

Health workers need to be trained in how to apply such criteria; it cannot be assumed that they will automatically do this properly. An excellent way to train staff is to give each worker a case description and then ask each of them separately whether the criteria are satisfied or not and hence whether the case should be reported. There is usually sufficient disagreement for a good discussion, which raises awareness and clarifies the issues.

Reporting cases

The district office should receive information on each case in the district through the reports. The details will vary according to local circumstances and what follows can only serve as a guide.

The essential information concerns the diagnosis and the frequency of the cases. In many situations further information may be needed on any of the following details: name, age (even if approximate), sex, address (at least name of village), occupation, vaccination or treatment status (if applicable), date of onset and duration of disease, death or not, place of infection (if known), source of infection (if known), and names of people exposed to infection who may need to be followed up.

In certain circumstances, such as when the disease is covered by quarantine regulations or is potentially epidemic, speed is needed and the reporting person may have to inform the district office by telephone or by messenger. Full information can follow later, with reporting forms or reports sent by post, e.g. at weekly or monthly intervals, although this will vary according to the local circumstances.

Table 5.1. Examples of diagnostic criteria, based on symptoms and signs, for reporting of possible cases by community health workers

Possible diagnosis	*Symptoms and signs*
Measles	Fever with red rash, red eyes, disappearing within a week
Poliomyelitis	Fever with paralysis
Trachoma	Chronic inflammation of the eyes, leading to shrinkage and turning-in of lids and blindness
Cholera	Sudden and severe watery diarrhoea with massive and rapid dehydration
Leprosy	Chronic hypopigmented skin lesions, loss of sensation, thickening of ear lobes, deformities of fingers, toes and face
Tuberculosis	Cough for 4 weeks or longer, loss of weight, bloody sputum, low fever, night sweats
African trypanosomiasis	Fever, swollen glands in back of neck, lassitude, headache, sleepiness
Cutaneous leishmaniasis	Chronic, round, slowly healing ulcers, often on the face or exposed parts of body
Malaria	Fever, rigors, headache, body aches and inability to carry out normal daily activities
Lymphatic filariasis	Fever, painful groin swellings, inflamed streaks in legs, elephantiasis, swollen genitals
Onchocerciasis	Itching of skin, nodules under skin, eye lesions, blindness
Schistosomiasis *(S. haematobium)*	Blood in urine of schoolchildren and teenagers
Ascariasis	Roundworms expelled
Guinea worm infection	Painful legs, skin ulcers with worm protruding
Tapeworm infection	Segments expelled in faeces

5.4 Sources of information

Health facilities

The main sources of information are often morbidity reports from health facilities including hospitals, health centres and clinics, private practitioners, and traditional practitioners. Traditional practitioners should be encouraged to use diagnostic criteria as discussed above. In these cases a confirmed diagnosis may not be possible without further investigation and reliance may have to be placed on criteria for possible and probable cases.

Ideally a senior person at each health facility should be responsible for periodically (e.g. each month) sending in information on

each case, or compiled data, in a report (an example of a report form is shown in Figure 5.3). Where active case detection is undertaken it may be necessary for district staff to visit health facilities to review case registers or even individual case notes.

Figure 5.3. Outline of a sample report

Monthly report of new cases

Health facility_____ Month_____ Year _____

Diagnosis	Name	Village	Age	Sex	Date of onset
1._____	_____	_____	___	___	___/___/___
2._____	_____	_____	___	___	___/___/___
3._____	_____	_____	___	___	___/___/___

Submitted by _____ Date ___/___/___

This source of information often has deficiencies, as the use of health facilities by the local population may be influenced by the distance of the facility from their homes, as well as by such factors as the cost of treatment. In addition, facilities may be unevenly distributed in the district. If one village has a health centre nearby whereas another village is 20 km from one, a comparison of the reported incidence in the two villages would not be valid. A knowledge of local attitudes to diseases or conditions is also important. If people are known, for example, to be reluctant to seek treatment for leprosy, reports from health facilities will reveal only a very small proportion of the new cases. By having a good local knowledge, the DHMT should be able to compensate for many of the deficiencies in routine and surveillance data from health facilities.

Death registration

This can be useful in countries and areas where a high proportion of deaths are registered. Registration can be very useful in epidemics when a few deaths are dispersed over a wide area.

Laboratories

These can be useful for information based on special tests that isolate an infectious organism or confirm a diagnosis. At present in most developing countries laboratories are usually found only in major towns, so that this source is likely to play only a minor role in most districts.

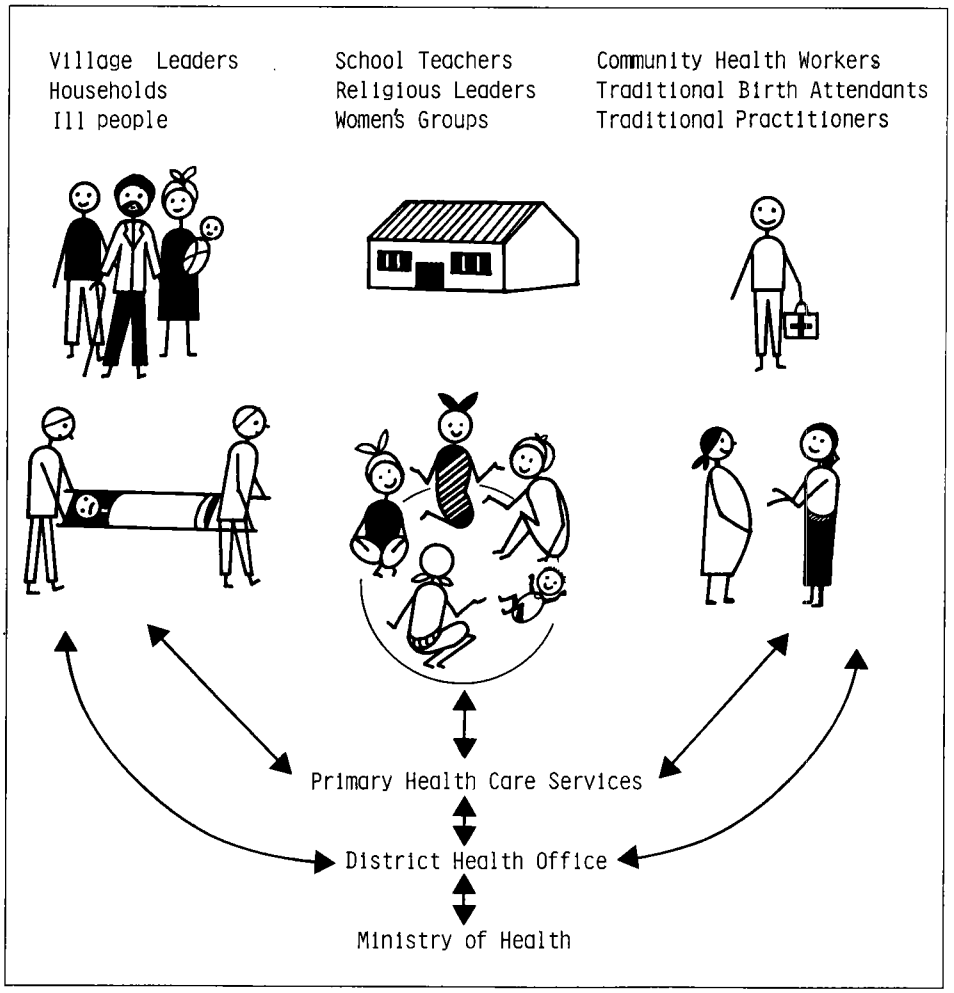
The community

Community surveillance of a limited number of key diseases and problems can be an integral part of primary health care by linking community health workers, traditional birth attendants and other groups to primary level health facilities (see Figure 5.4). Such surveillance can also be useful to staff employed in special programmes, such as malaria and family planning.

Simple and standardized diagnostic criteria need to be used and the examples in Table 5.1 are a useful guide for simplified reporting by the community. Many of these diseases are of course well recognized by local people, who give them names in their local languages.

For some selected problems or diseases members of the general public may be asked to make reports. If so, efforts must be made to collaborate with the community and secure its cooperation. Of special importance in this regard will be schoolteachers, religious leaders and government administrative officers. Radio broadcasts may be used for publicity, especially in remote areas. Cases reported by the public may also need to be checked by a health worker or a laboratory.

Figure 5.4. Some ways of organizing community surveillance



5.5 Additional sources of health information

Special searches

Special searches can be made in schools, markets, particular villages and high-risk households in order to improve case detection. These searches should be done by health workers, or people who are specially trained. In schools, teachers and children can be asked whether or not they know of any cases. In both schools and markets it is useful to show a picture of a person with the disease, with the symptoms and signs described. When a worker is told of a possible case, details of the person's name, age, sex and address and the informant's name and address should be noted down. This information can then be followed up and, if the diagnosis seems reasonable, full information obtained.

Investigation of outbreaks

Outbreaks of disease will need to be investigated and all possible cases identified. The investigation of an outbreak is described in Chapter 6. In an outbreak it is important to organize active case-finding, if necessary by carrying out surveys in surrounding villages. Details of all known cases in an outbreak should be recorded and notified.

Surveys

Surveys can be very useful for the periodic surveillance of some conditions. They can also be used to estimate the coverage of the regular reporting or surveillance systems and to monitor changes in completeness of reporting. (For an example, see Section 5.8.)

When the survey is analysed, it is important to keep in mind that there may be both over-reporting and under-reporting. Over-reporting, because cases are falsely diagnosed, can be checked by investigating reported cases and determining whether they have been correctly diagnosed or not. However, under-reporting can only be determined by checking whether the cases identified in a special survey had been notified by the routine or surveillance system (using identifying information such as names and addresses). Accuracy of reporting (taking into account both over-reporting and under-reporting) is estimated by comparing the number of cases reported with the number of cases estimated from the survey.

In summary, the main sources of information are:

- Health facilities.
- Death certificates.
- Laboratories.
- The community.
- Special searches.
- Outbreak investigations.
- Surveys.

5.6 Analysis and presentation of data

The collected data need to be analysed and presented in a simple but clear way. How this is done will depend on the local situation; what follows can serve only as a guide.

A **register** is a book or file containing the recorded data. Each case may be entered in one register, or a separate register may be used for each condition. An example of a page from a register for one disease is shown in Figure 5.5. The details, especially name and address, should be checked against previous entries so as to avoid counting a case more than once.

Figure 5.5. Register for recording details of reported cases of a particular disease

Disease or problem _____ *Reporting period* _____

Serial no.	Date	Name	Village	Age	Sex	Death or not
_____	__/__/__	_____	_____	___	___	____
_____	__/__/__	_____	_____	___	___	____
_____	__/__/__	_____	_____	___	___	____
_____	__/__/__	_____	_____	___	___	____

At the end of the reporting period (e.g. monthly) tables can be made of the cases by **who?** (e.g. age and sex) and **where?** (e.g. village of onset), as shown in Figures 5.6 and 5.7. The number of deaths can be reported if required. Ideally, cases should be reported by date of onset, but in practice it may only be practical to report by date of diagnosis.

Figure 5.6. Suggested table for analysis of cases by age and sex

Disease or problem _____ *Reporting period* _____

Sex	Age group (years) 0-4	5-14	15-44	45+	Total
Male	_____	_____	_____	_____	_____
Female	_____	_____	_____	_____	_____
Total	_____	_____	_____	_____	_____

Figure 5.7. Suggested table for analysis of cases by place of onset

*Disease or problem*_____ *Reporting period*_____

Number of cases by place (e.g. village)

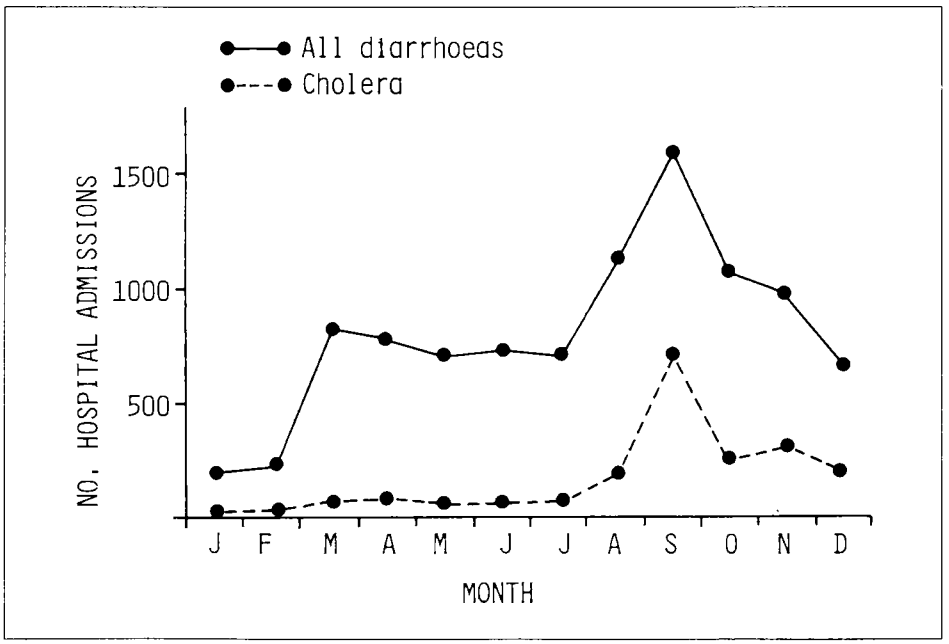
A	B	C	D	E	Total

For a specified reporting period (e.g. one year) the district office can indicate **where** the cases occurred by using pins in a map of the district. This is called a **spot map** and it will readily indicate where diseases are occurring most commonly. In particular, the clustering of cases may indicate that a disease is more common in a particular locality or that there is an outbreak.

ANALYSE ALL CASES BY "WHO? WHERE? AND WHEN?"

The district office should also keep a check on the incidence or total number of **new** cases occurring each month. This is best done by entering cases on a chart or graph at the end of each reporting period (by month, for example, as in Figure 5.8). An analysis of incidence over time by **who?** factors, such as age, sex and occupation, may help to identify high-risk groups. Time trends over longer periods can be brought out by continuing the analysis over several years, as in Figure 5.2. When interpreting time trends it is important to consider seasonal variation and remember that when a new reporting

Figure 5.8. Analysis of hospital admissions for all diarrhoeas and cholera by month *(based on data from the International Centre for Diarrhoeal Diseases Research, Bangladesh)*



or surveillance system is implemented, the completeness of reporting may increase, thereby giving a false impression of an increasing frequency. Conversely, when a system has been in operation for several months or years, the reporting tends to deteriorate and there is likely to be under-reporting, or even falsification of reports. This usually calls for improved supervision and retraining of health staff.

In practice the total number of cases rather than a rate is usually used. This is sufficiently accurate providing the size of the population is reasonably stable. However, for the comparison of different districts or different population groups within the district, it will probably be necessary to calculate rates, using as the denominator the actual or estimated size of the population at risk.

5.7 Communicating and using the information

The information from a reporting or surveillance system, together with what that information means, should be communicated to all relevant people, in particular to:

- Regional and national staff, so that they are informed of local situations and can compile information for larger areas.
- Primary health care workers involved in sending in the original data and reports.
- Health workers involved in organizing community health programmes, particularly all district health staff.
- Village councils and other local organizations.
- Nongovernmental and voluntary organizations.
- Local mass media, such as local radio stations.

WILL THE INFORMATION BE USED? WHAT DIFFERENCE WILL IT MAKE?

However, the main reason for having such reporting and surveillance systems must be that the information is used to improve the planning of health programmes and disease control activities. If the information remains unused, organizing a reporting or surveillance system can be a waste of staff, time and money!

5.8 Effectiveness of reporting or surveillance systems

Example: Suppose the DHMT is interested in finding out the frequency of attacks of malaria in the district and the completeness of the reporting or surveillance for this disease. The diagnostic criteria for an attack are fever and chills which prevent people from doing their normal work. (The same principles can be applied to other examples, such as the reporting of births or immunization coverage.)

The population consisted of 50 villages with a total of 8500 houses and an average of 5.1 persons per household.

The sample consisted of 20 randomly selected villages. Within each of the selected villages one house was chosen randomly as the starting point, and then the next 19 houses in any one direction were taken. This gave a cluster of 20 houses in each of the 20 villages, making 400 houses or an estimated 2040 people in all.

Assessment of the incidence of malaria was done by paramedical workers, previously trained by the health officer, who visited the houses and asked the question:

"Over the last 4 weeks has any member of this household had an attack of intermittent fever, with chills, preventing him or her from doing normal activities?"

(Alternatively, the local name for malaria could have been used if a malaria attack is a well recognized condition.)

The total number of such cases was recorded.

Results: 30 persons were found to have had an attack of probable malaria, starting in the previous 4 weeks, an incidence rate of nearly 15 attacks per 1000 people per month.

The estimated incidence of probable malaria per month for all households is:

$$\frac{30}{\text{no. of houses in sample}} \times \text{total no. of houses} = \frac{30}{400} \times 8500 = 638 \text{ cases}$$

From the records it was found that, over the same period of 4 weeks, 82 cases were reported by the surveillance system from the 8500 households.

The completeness of reporting is therefore:

$$\frac{\text{cases reported}}{\text{cases estimated from survey}} = \frac{82}{638} \times 100 = 13\%$$

Conclusion: Only about one in seven of the probable cases of malaria was being reported. Why is this? The DHMT now needs to conduct an inquiry, starting by questioning cases at home and then examining all steps in the information system in order to detect all possible ways of correcting this under-reporting.

5.9 *District reporting systems checklist*

- Diseases or health problems being reported:
  - which cases, episodes or attendances?
  - diagnostic criteria and working definitions being used
  - estimates of under- and over-reporting.

- Sources of health information:
  - health facilities
  - death registration
  - laboratories
  - the community
  - special searches
  - outbreak investigations
  - surveys.
- Analysis and presentation:
  - registers
  - files
  - monthly graphs
  - spot maps
  - special reports.
- Communication of findings:
  - ministry of health and regions
  - primary health care workers and district staff
  - village councils and organizations
  - nongovernmental and voluntary organizations
  - local mass media, radio.
- Use of information in health planning:
  - coverage of reporting and surveillance system
  - improvements to community health programmes
  - improved district health plans
  - use of information in community health education
  - changes in district health status indicators.

CHAPTER 6
Controlling an Epidemic

6.1 *Definition of an epidemic*

An **epidemic** is commonly defined as the occurrence in a community or area of cases of a disease that are clearly in excess of what is expected.

Although epidemics of different diseases happen in different ways, the district management team will need to follow a reasonably systematic approach in order to avoid confusion. This chapter suggests an orderly sequence for investigating and controlling an epidemic, but how the steps and procedures are actually used will differ, naturally, according to the disease and the local circumstances. The approach is summarized diagrammatically in Figure 6.1, which shows the importance of the two main components – **investigation** and **control**.

Serious epidemics are uncommon and the DHMT will probably only have to handle one every few years or so. However, the early stages of an epidemic may be shown by the reporting or surveillance systems and the DHMT is then required to bring the potential epidemic under control. Most important epidemics are due to communicable diseases with a short incubation period that are easily transmitted. Food-borne diseases and cholera are good examples. However, epidemicity is relative to the previous incidence of the disease in the same area, among specified population groups and at different seasons of the year. The appearance of two cases of plague in an area may constitute an epidemic, whereas a high incidence of diarrhoeal diseases during the peak diarrhoeal season may be considered the normal frequency. Measles and influenza are two other diseases that can show marked seasonal and annual variations in incidence.

Epidemics may commonly be due to:

- Food-borne outbreaks, e.g. enteritis due to *Escherichia coli*, staphylococcal infection, salmonellosis.
- Communicable diseases with short incubation periods, e.g. dengue, cholera, influenza, malaria, measles, plague, yellow fever.
- Communicable diseases with longer incubation periods, e.g. African trypanosomiasis, viral hepatitis, kala-azar.
- Toxic substances, e.g. contaminated foods, insecticides and agricultural chemicals.

An epidemic may be detected by:

- Community leaders, such as politicians and teachers.
- Health workers in primary health care facilities.
- District health information and surveillance systems.
- Hospitals.

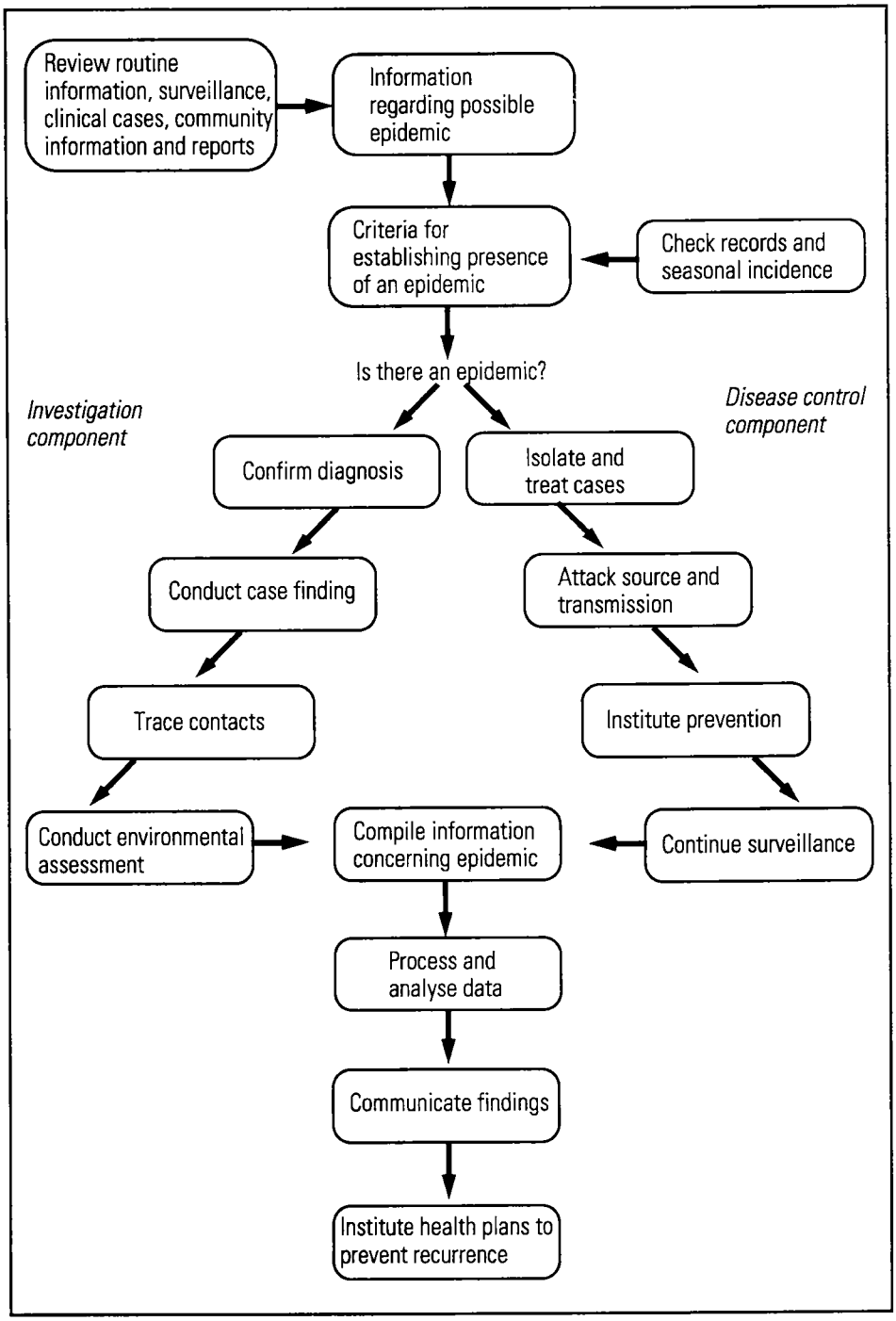
It is important to recognize a potential epidemic, and then to determine the existence and size of the outbreak and to develop ideas about the cause, method of transmission and best methods of control. A judgement as to whether an epidemic exists or not can be a highly political issue and it would be wise for district staff to consult with their district and ministry of health colleagues before making public announcements.

6.2 *Confirming the epidemic*

The main steps in the investigation and control of an epidemic are shown in Figure 6.1. The initial step is to review the **reported cases** in order to diagnose the problem. This can usually be done by analysing the clinical case histories and laboratory tests. Specimens, e.g. of blood or faeces, may be taken and sent for further laboratory tests. If laboratory facilities are few or non-existent, action should be taken on the basis of a clinical diagnosis before the results of the tests are available. It may be necessary to consult a more experienced health worker or to request advice.

At this stage it is important to review the **diagnostic criteria** that would be needed to differentiate non-cases from cases and to classify the latter as possible, probable or definite cases. This is particularly important when cases are not easily diagnosed clinically and a disease may be transmitted through subclinical or asymptomatic infections. The best information about why the epidemic has occurred is most likely to come from the analysis of the probable and definite cases. It is also important to make these criteria clear before searching for other cases, even though the criteria may be modified later in the light of further experience.

Figure 6.1 Outline of the investigation and control of an epidemic



WHAT ARE THE DIAGNOSTIC CRITERIA FOR A POSSIBLE, PROBABLE AND DEFINITE CASE?

Interviewing is a technique that requires skill, and health workers need to help suspected cases feel at ease when giving details of their illness. Interviewing cases also helps to identify contacts or additional cases and to recognize special circumstances that might help explain the outbreak. In order to standardize the interview procedure, special case-history forms may be designed after the initial cases have been thoroughly interviewed and examined.

An epidemic can be confirmed by comparing the incidence of the disease with that in the recent past or at a similar time in previous years for the same community. Alternatively, an outbreak may be confirmed if a number of cases are clustered and come from the same place at a similar time. It should be noted that with some diseases, such as yellow fever or cholera, only a few cases will need to be investigated to confirm whether an epidemic exists and later a special search can be undertaken to find any unreported or unsuspected cases. This extremely important step is called **active case detection.** Some cases will be obvious but others may be mild and identified only by such detailed inquiries.

Once the **source of the outbreak** is known, further cases may be discovered by contact-tracing, that is, following up all the people in contact with infectious cases or the same source of infection in the outbreak. This is essential when all cases need to be treated or isolated. If the incubation period is a long one, contact-tracing can be a difficult task.

6.3 *Describing the epidemic*

Information should be obtained on the age, sex, residence and occupation of known cases, as well as the **date and time of onset** of the illness and the whereabouts of cases during the period of incubation of the disease. Other relevant questions need to be asked. For example, malaria is usually transmitted by a night-biting mosquito *(Anopheles)* and so residence is important, whereas dengue fever is transmitted by a day-biting mosquito *(Aedes)* and so place of work may be important. A knowledge of the disease concerned can help greatly in focusing the investigation.

The basic questions about an epidemic that need answering are:

- What is the disease causing the outbreak?
- What is the source?
- What is the mode of transmission?
- How can the epidemic be explained?

WHAT DO ALL CASES HAVE IN COMMON?

To find these answers it is important to analyse all the information on **who? where?** and **when?** contained in the case interviews to see in what way all cases are similar. Early in the analysis, the actual number of cases may be used, but later age- and sex-specific attack rates will probably be needed.

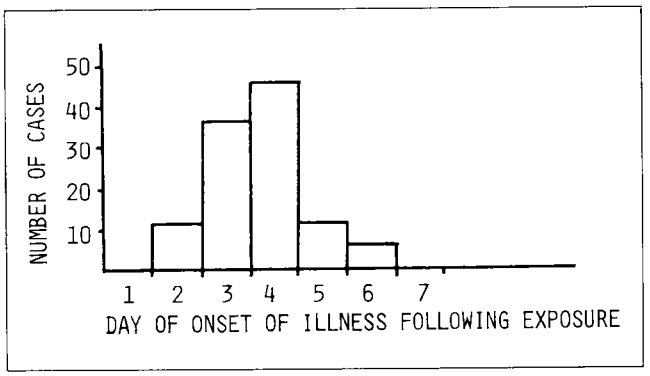
Epidemic incidence curve (when?)

A graph that plots cases of the disease by the time of onset of the illness is called an **epidemic incidence** curve and it is an essential part of the analysis. This graph can indicate the nature of the outbreak and the probable source.

A **point-source** or **common-source** outbreak is one where there has been a simultaneous exposure of many susceptibles to a pathogenic agent resulting in a rise in the incidence of cases of the disease over a short time, approximating to the incubation period of the disease. This is an important clue. This type of outbreak is characteristic of water-borne diseases, such as cholera and typhoid, and food-borne diseases. A typical epidemic curve is shown in Figure 6.2.

The graph may be modified in epidemics where the point source provides continuous exposure over a longer period of time—an **extended point-source** outbreak. In this situation the onset will be abrupt, but the incidence of cases will be spread over a greater period of time than one incubation period.

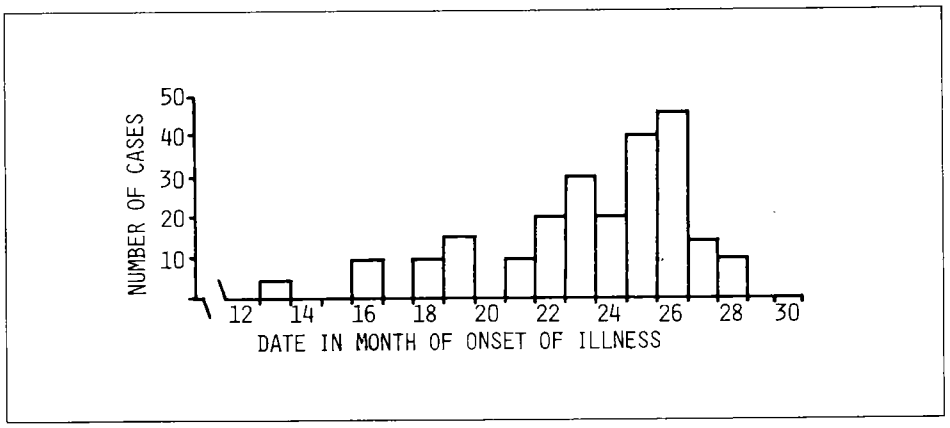
Figure 6.2. Epidemic curve of a point-source outbreak



In the example in Figure 6.2 the exposure is assumed to have taken place on day 0 and the incubation period therefore appears to be between 2 and 6 days, with an average of 4 days. This epidemic curve is very similar to that expected in a cholera outbreak.

IN A POINT-SOURCE EPIDEMIC MOST CASES WILL OCCUR WITHIN ONE INCUBATION PERIOD

Figure 6.3. Epidemic curve of a propagated epidemic



In the example in Figure 6.3 the source case is unknown and the first detected cases appeared on the 13th day of the month,

with subsequent cases appearing at about 3-day intervals. This is reasonably typical of a **propagated epidemic** due to person-to-person transmission, such as occurs in shigellosis.

The shape of a propagated epidemic curve (as in Figure 6.3) will depend on the incubation period of the disease and the suitability of the environment for transmission. The longer the incubation period the more spread out the cases will be. For contact-spread outbreaks, the degree of crowding and intimacy of contact will determine the rapidity with which the epidemic reaches a peak, while the proportion of the population that is susceptible will influence the extent of the outbreak. For vector-borne diseases, the time the organisms take to develop in the vector and conditions favouring the development of the vector itself will also affect the shape of the curve.

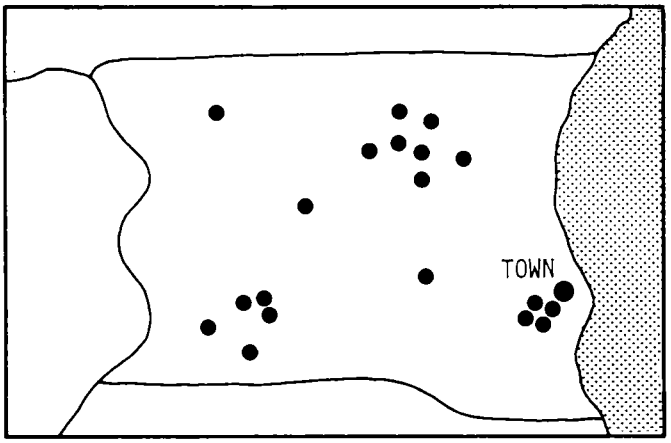
An epidemic curve can provide further information. If the organism, and therefore its incubation period, is known, then the probable time of exposure can be determined. For example, if Figure 6.2 represents a cholera outbreak, it could be deduced that exposure occurred between 2 and 5 days (the usual incubation period of cholera) before days 3 and 4 when most cases occurred. Similarly, if the epidemic in Figure 6.3 were due to a shigellosis outbreak, it could be estimated that the first cases on the 13th day of the month had been exposed to a source case about 3 days previously (the usual incubation period of shigellosis). This use of a known incubation period helps to trace the source of the infection.

Conversely, if the time of exposure is known, the incubation period can be calculated and this is a clue to the causative organism. This applies particularly to food-borne disease outbreaks where the time of exposure is usually known. For example, if the epidemic in Figure 6.2 was a food-poisoning outbreak and the meal had been taken at midday on day 2, the median incubation period could be calculated as around 24 hours, which would indicate salmonellae rather than staphylococci as the probable infecting organism. It should be noted here that incubation periods are best expressed in terms of the median and range. The mean or average is not used because there may be some extremely long or short incubation periods in many outbreaks, which tend to pull the mean away from the central clustering of cases.

Analysis of cases by who? and where?

Analysis of the cases by personal factors such as age, sex and occupation may also give clues to the source of the infection. For example, if the initial cases are mainly in children, the source may be in the vicinity of their school, whereas if adult men are affected, the source may lie at work, in the fields, or elsewhere. Again it may be necessary to calculate rates in order to compare attack rates in different population groups.

Figure 6.4. District spot map showing clusters of epidemic cases



Marking known cases on a "spot map" (see Figure 6.4) may indicate a possible source of infection. Often only known cases are marked on the map, as in this example. However, it may also be important to know the distribution of the general population. For example, if 70% of the population in this district live in the town, then the apparent cluster in town is actually a relative deficiency, indicating that the disease is mainly rural.

When all cases occurring within a short time period (e.g. 2-3 days for shigellosis, one week for cholera and two weeks for typhoid) are marked on the map in one colour, and other cases beyond that time in different colours, the spread of the epidemic may become apparent. The clustering of cases together in one area and at about the same time, also called **space-time clustering**, indicates a localized epidemic.

6.4 *Case-control analysis*

Descriptive analysis by **who? where?** and **when?** may provide sufficient information about the source of the outbreak for appropriate control action to be taken immediately. In other outbreaks, however, further analysis may be necessary.

A **case-control study** is often used for this analysis. Patients are questioned to determine what contacts they have had with possible sources, as suggested by the incubation period. Exactly the same questions are then asked of a group of control people who live in the same area but who do not have the disease. There should be at least one control person for every case. A useful way of selecting controls is to interview a person of the same sex and age (within 5 years) as the case who lives in a neighbouring household in which there are no known cases. Try to avoid asking leading questions in the interview; however, since people may have difficulty in remembering what they previously ate, for example, a checklist approach is often helpful. If possible, interviewers should not know the explanation for the epidemic so as to avoid the recording of biased answers.

Case-control study techniques involve:

- Interviewing both cases and controls using exactly the same questionnaire to identify possible sources of infection.
- Analysing data from cases and controls to find the percentage of each group that had contact with each of the possible sources.
- Looking for any significant differences.

Example: Three sources of drinking-water were considered the possible origin of a cholera outbreak. By questioning the cases and a similar number of controls about the water they had been drinking 2 to 3 days before the outbreak, the investigators tried to determine the true origin of the infection. This is illustrated in Table 6.1 where it can be seen that water source B is the most likely source for the outbreak, even though each person probably used more than one source of water. This technique becomes less feasible the longer the incubation period.

Table 6.1. Case-control study of 18 cholera cases by water source used

		Water source used		
	Total	*A*	*B*	*C*
Cases	18	17	16	6
Controls	18	14	3	17

It can be seen from this table that if only the 18 cases had been questioned, the likely source of infection could have been either water source A or B. The addition of controls shows that far fewer of them had taken water from B and thus this source is implicated. Sometimes it may be necessary to perform tests of statistical significance if the differences are not clear-cut. It may be asked, when looking at the table, how it was that there were 2 cases of cholera who had not taken water from source B. In such an investigation, there are always some errors or people who give an incorrect history. Likewise the 3 controls who said they had taken water from source B may in fact not have done so or they may have taken the water but did not succumb to the disease. It is the difference between the cases and controls that is important.

Another useful method, particularly for food-borne epidemics, is to compare the **attack rates** for illness among all those having eaten particular foods. In this case the attack rate should be high among the exposed population, but it will be lower for the unexposed population.

6.5 Environmental assessment

A systematic analysis of the data may indicate an environmental source for the outbreak. This can be confirmed by obtaining samples of suspect food or water for examination in a laboratory (if facilities are available) for toxic chemicals or faecal contamination. Breeding sites for disease vectors may also need to be investigated. The help of a local health inspector who knows the area may be useful in such investigations.

6.6 Control of epidemics

When the causative organism, its source and the route of transmission are known it will probably be easy to explain why the epidemic occurred. Control measures depend on the individual disease concerned. The main strategies for the **control of communicable diseases** can be summarized under three headings, as in Table 6.2.

Table 6.2. Main strategies for the control of an epidemic due to a communicable disease

Attack source	*Interrupt transmission*	*Protect susceptible people*
Treatment of cases and carriers	Environmental hygiene	Immunization
Isolation of cases	Personal hygiene	Chemoprophylaxis
Surveillance of suspects	Vector control	Personal protection
Control of animal reservoirs	Disinfection and sterilization	Better nutrition
Notification of cases	Restrict population movements	

Primary prevention is achieved by all the measures listed under "interrupt transmission" and under "protect susceptible people," together with control of animal reservoirs. If all these are properly performed the number of new cases should be greatly reduced. Thus clean water supplies and the correct disposal of faeces could prevent the spread of cholera, control of anopheline mosquitos could reduce malaria transmission, and immunization could protect young children against measles.

Secondary prevention can be achieved by finding subclinical cases and carriers and by contact-tracing and surveillance.

Tertiary prevention is by the treatment of cases or carriers so that they do not spread the organism any further.

The main elements in the control of an epidemic are, therefore, as follows:

Attack source and mode of transmission. Contaminated water should be prohibited or sterilized, infected food destroyed, and vector breeding sites dealt with. Health education has a large part to play in this work and even legislation may be necessary.

Treat and isolate all cases. The treatment given will vary with the disease and the facilities and supplies available.

Increase resistance of local population. Some communicable diseases can be prevented by chemoprophylaxis (for example malaria) or immunization (for example, poliomyelitis and measles). It should be borne in mind that in epidemics of some diseases, such as typhoid and cholera, vaccination is relatively ineffective.

Continue surveillance. During the acute phase of the outbreak, it is necessary to keep suspects at special risk under observation. Once the epidemic is under control, surveillance for new cases should be carried out to ensure that the control measures have been effective. The routine reporting system may not be adequate to show this and special surveillance may be needed. Community surveillance may then be an important means of recognizing and reporting any new cases.

6.7 *Reporting on the epidemic*

The DHMT should report early on a possible epidemic to colleagues in the ministry of health and to other district officers so that the disease control authorities can institute their own procedures. A brief report on the epidemic should be written and should include recommendations for measures to prevent any similar outbreaks in the future.

The report should cover the following points:

- Causative organism and probable routes of transmission.
- Description of the epidemic curve, the geographical distribution and main features of the cases.
- Explanation of the reason for the epidemic.
- Disease control measures that were introduced.
- Recommendations for improvements to prevent the epidemic occurring again.

Copies of the report should be distributed to the regional health officer, ministry of health, senior district government officers, health workers in charge of district health facilities, and community leaders and other local organizations.

6.8 District epidemic checklist

- Collect information to answer the question: Is there an epidemic?
  - review cases for probable diseases and define diagnostic criteria for possible, probable and definite cases
  - check health information system for cases
  - search for missed cases
  - review previous levels of endemicity and local knowledge.
- Describe the epidemic:
  - when? epidemic incidence curve
  - where? mapping of cases
  - who? characteristics of cases
  - collect information on population at risk to establish denominators.
- Answer question: What caused this epidemic?
  - causative agent
  - source and transmission
  - exposure
  - susceptibles and high-risk groups
  - use case-control method to test explanation
  - collect additional specimens for laboratory investigation.
- Institute control measures for the particular disease:
  - attack source
  - interrupt transmission
  - protect susceptible people
  - notify authorities
  - write and distribute report.

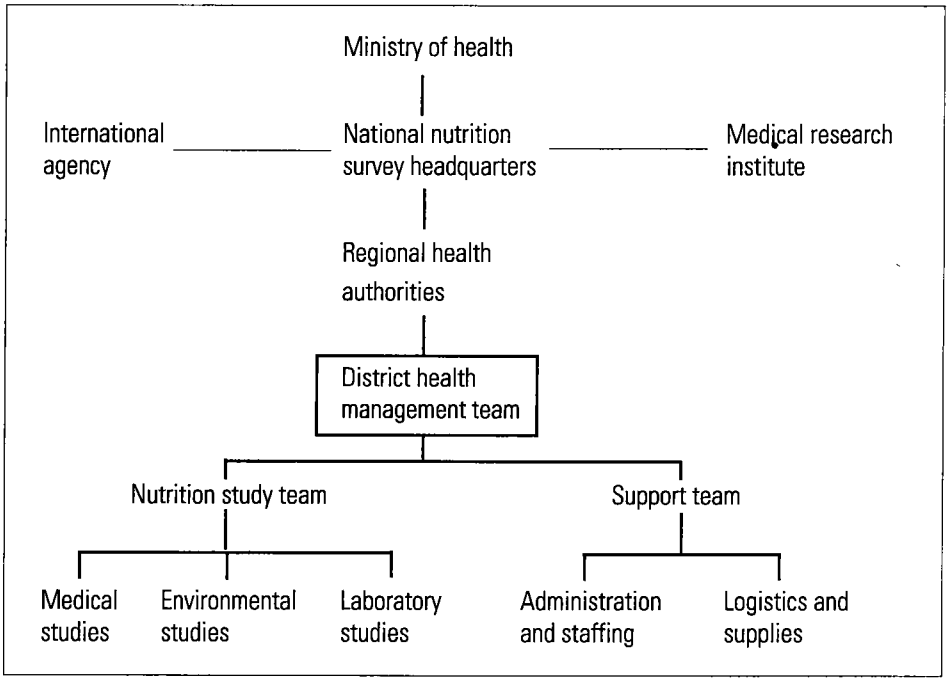
CHAPTER 7
Epidemiological Surveys

7.1 *Uses of surveys*

Surveys offer a very useful way of collecting **additional information** that is not available from the routine health information or surveillance systems – a common situation in many developing countries. However, as surveys consume staff, time, and money, the DHMT should be convinced that the required information is not available from reports or other ministries and that a survey would be the most desirable way to obtain it.

The DHMT will encounter many situations in which it may be desirable to undertake an epidemiological survey. In some countries the most frequent reason for such investigations will be to form part of a nationally organized survey undertaken, for example, to find out the prevalence of leprosy, blindness or some other chronic condition or to assess the effectiveness of a particular health programme. The DHMT will not usually be directly involved in the planning and preparation of the protocol, but may well need to implement it locally and should understand why the survey is being done and the reasons for each step. For example, Figure 7.1 shows how district health staff might become involved in a national nutrition survey and what might be expected from them.

Figure 7.1. Possible district involvement in a national nutrition survey



There will also be occasions when the DHMT wishes to organize an epidemiological survey to estimate, for example, immunization coverage. Other examples might be to find out why one group of householders is not cooperating with the antimalarial spray team or to screen schoolchildren for a communicable disease such as leprosy or schistosomiasis. It is a good principle always to offer some health service to the people being surveyed – **no survey without service!**

Surveys are commonly made to:

- Estimate the incidence or prevalence of important diseases, e.g. leprosy, malaria, malnutrition, schistosomiasis.
- Screen population groups for treatment of important diseases, e.g. pregnant mothers, young children, schoolchildren, plantation or factory workers.
- Provide health information about households and their members, e.g. excreta disposal, water supplies, food habits.
- Find out about local beliefs, customs and health behaviour, e.g. use of local foods, breast- and bottle-feeding, smoking.
- Evaluate how effective the health services are, e.g. antenatal attendance, immunization coverage, utilization of outpatient clinics.

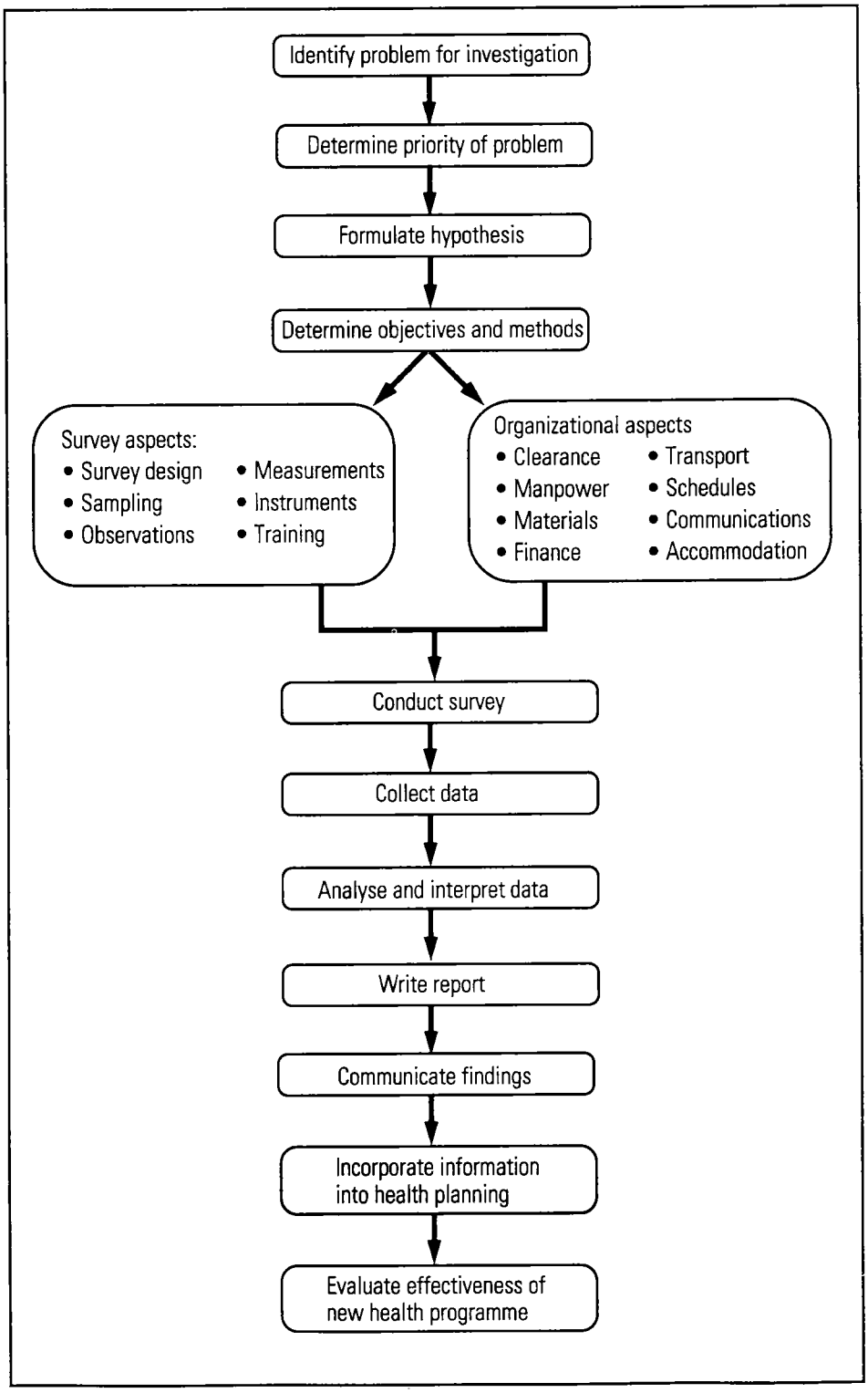
There are five main stages involved in an epidemiological investigation:

- Clarification of the need for the survey and statement of objectives.
- Determination of the sample and methods.
- Organization and implementation of the survey.

- Analysis, interpretation and presentation of findings and recommendations.
- Use of findings in health planning and disease control.

These are illustrated in more detail in Figure 7.2.

Figure 7.2. Outline of the main steps in an epidemiological survey



7.2 Cross-sectional and longitudinal surveys

Cross-sectional surveys examine people at one point in time and therefore provide prevalence data, particularly for infections or conditions that last a relatively long time such as malnutrition and African trypanosomiasis. The "point in time" may last up to several weeks or months, provided that the incidence of the condition being investigated does not change much during these weeks. However, for a disease or event that shows considerable seasonal fluctuation, a careful choice should be made of the best time of year to undertake the survey.

CROSS-SECTIONAL SURVEYS COLLECT MAINLY PREVALENCE DATA

Longitudinal surveys collect information about all the new cases or events occurring over a period of time and therefore supply incidence data, e.g. new cases of measles or tuberculosis, or the number of pregnant mothers attending the antenatal clinic for the first time. The time period for collecting the incidence data must be defined. Longitudinal surveys may be organized in a similar way to the surveillance of communicable diseases.

Senior district health staff should be able to organize their own cross-sectional surveys for common problems, but longitudinal surveys are more complicated and for these they should seek further advice. Some incidence data can be collected during cross-sectional surveys by asking people about events in the previous two weeks. If repeated cross-sectional surveys are carried out on the same population and all new cases occurring after the first survey but before the second one are found, then an estimate of the incidence of the disease or event can be calculated. However, this is possible only for chronic diseases that do not come and go between the two surveys. Cross-sectional surveys are rarely repeated within one year. A repeat survey should be carried out in the same month as the initial survey to avoid seasonal changes that might affect the frequency of the disease or event.

The main points about cross-sectional surveys are that they:

- Mainly provide information on prevalence.
- Are useful for descriptive information, screening and estimation of use of services.
- Are not useful for rare diseases or events.
- Are not useful for diseases or events of short duration.
- Are fairly quick and easy to organize.
- Give prevalence data that may be difficult to interpret.
- Can give an estimate of incidence if two cross-sectional surveys are carried out.

7.3 Survey objectives

At an early stage it is important for the DHMT to be clear about precisely what questions are being asked and then to decide if a survey can indeed provide the necessary answers. The question should be simply and clearly stated, for example:

> *What is the prevalence of malnutrition among villagers in this district?*

The objective might be to determine the prevalence of mild, moderate and severe malnutrition among children aged 12-36 months living in the district.

The objectives will determine the population to be surveyed. Criteria will have to be stated for mild, moderate and severe malnutrition. Lack of clarity in the precise question and the formulation of objectives is a very common fault in surveys.

At this time, the major end-results expected from the analysis should be worked out in the form of "dummy tables." For example, suppose it is planned to carry out a survey to relate haemoglobin level to the presence of hookworm infection, according to the age and sex of the patient. The preparation at the outset of the dummy tables shown in Figure 7.3 would help to clarify the objectives. These tables show the key relationships that are expected to emerge from the investigation.

Figure 7.3. Sample dummy tables

The distribution of hookworm-infected subjects by haemoglobin level.

Haemoglobin level	*Hookworm infection*		*Total*	*% with hookworm*
	present	*absent*		
Less than 10 g per 100 ml				
10 g per 100 ml or more				
Total				
% with anaemia				

Figure 7.3. Sample dummy tables (continued)

Distribution of the villagers by age, sex and haemoglobin levels

Haemoglobin level (g/100 ml)	*Age group (years)*								*Total*	
	0-4		*5-14*		*15-45*		*45+*			
	M	*F*	*M*	*F*	*M*	*F*	*M*	*F*	*M*	*F*
6.0										
7.0										
8.0										
9.0										
10.0										
11.0										
12.0										
13.0										
Total										

7.4 *Selecting the sample*

All the people being investigated are called the **reference population**, but it is unusual to investigate each and every one of them. It is more common to select a **sample**, called the **study population**, in such a way that each person in the reference population has an equal chance of being included in the study. In this way selection bias is avoided and the study population will probably be representative of the reference population. Incorrect or poor sampling is another common fault in surveys.

EACH INDIVIDUAL SHOULD HAVE AN EQUAL CHANCE OF BEING IN THE SAMPLE

Studying the entire population can involve too much time, manpower and money. Moreover, the very size of such a large study might introduce errors. In some instances, however, examination of the entire population is unavoidable, for instance when information is required on all cases during an epidemic or when selection of a group of people for the study would create a strong feeling of discrimination in the population.

In organizing a survey it is important to define which people are to be surveyed: for example, which sex, age group, occupation and area. This helps in selecting the sample and keeping the amount of survey work down to a minimum. There are two main methods of drawing a sample—**random** and **systematic**. For statistical reasons, randomsampling is more likely to provide a study population that is representative but systematic sampling may be easier to do in practice.

The following are the main steps for drawing a simple random sample:

- Decide what is to be the **unit of sampling**. This may be a person, household or village, as appropriate.
- Make a list of all available sampling units from which the sample is to be drawn. This is called the sampling frame.
- Decide the number of units that need to be randomly chosen from this sampling frame. This is called the sample size, and this number divided by the total number of available units in the sampling frame is called the sampling fraction.
- Pick the required number of units from the sampling frame by a method which ensures that all units have an equal chance of being picked, i.e. randomly. This can be done either by drawing lots or by using a table of random numbers (see Appendix 3, page 177).

A systematic sample may be chosen as follows:

- The first unit is chosen randomly.
- Then choose the next units in a systematic manner, e.g. every fifth person on a list, every third hospital admission or every tenth house on a street.
- Often different random starting units are selected to give several clusters.

It is often not possible to obtain a complete sampling frame of individual people. Such detailed information is often not available and to obtain it would be costly and time-consuming. One solution is to use randomly selected villages or households in place of individuals. A **cluster sample** is recommended for collecting information on a variable that is common; one way of obtaining such a sample is by the "30 clusters of 7" technique. Thirty individual villages—a cluster of households—are chosen randomly and then within each cluster seven households or people are again chosen randomly. This technique was originally developed for estimating immunization coverage, but has now been widely used for descriptive cross-sectional surveys. This sampling method is suitable for use when a relatively common condition is being investigated, but it does not give sufficiently accurate estimates for rare conditions. It is also not a suitable sample to use to measure changes in health status (see Sections 2.8, 2.9 and 13.3).

CLUSTER SAMPLES ARE COMMONLY USED FOR CONVENIENCE

Cluster samples have several advantages:

- Only a simple sample frame is needed, e.g. number of villages.
- It is easier and faster to do the survey because people are grouped together.
- It is often more acceptable to the local community.

7.5 Sample size

In general, the larger the sample the more reliable will be the estimate of prevalence obtained. Table 7.1 provides a guide to the sample sizes required for different prevalence rates. For instance, if the expected prevalence rate of a particular condition is about 40%, then the prevalence for a random sample of 50 people will probably be between 26% and 55%. If we examine a sample of 200 subjects this range falls to 33%-47%. Clearly there is a significant gain in accuracy in going from 50 to 200, but not a great deal more accuracy is obtained by examining a sample of 500 subjects. For many purposes, a sample of 100-200 subjects for a common condition will be sufficient. However, when greater accuracy is required or conditions with a low prevalence are being investigated, a much larger sample size will be needed. For a more detailed discussion on estimating sample size see Appendix 2, page 175.

Table 7.1. Relationship between expected prevalence and range of prevalence estimate determined by survey, according to sample size

Previous estimates of prevalence	*Number of people in sample*				
%	50	100	200	500	1000
	Probable range for prevalence estimates				
1	—	0 5	0.1 4	0.3 3	0.5 2
5	—	2 11	2 9	3 8	4 7
10	3 22	5 18	6 15	7 13	8 12
20	10 34	13 29	15 26	16 24	18 23
30	18 45	21 40	24 37	26 35	27 33
40	26 55	30 50	33 47	35 45	37 43
50	36 64	40 60	43 57	45 55	47 53
60	45 74	50 70	53 67	55 65	57 63
70	55 82	60 79	63 76	65 74	67 73
80	66 90	71 87	74 85	76 84	77 82
90	78 97	82 95	85 94	87 93	88 92

7.6 Response rate

Even if samples are well chosen, surveys can still give misleading results if a high proportion of the households or individuals are not contacted or they do not answer the questions. This is called the **non-response rate**. A bias can be introduced by selecting those who are seen and by missing out those who are not seen. For instance, a village survey in a rural area done during the day may miss the young men and women who are working in the fields or paddies.

FOLLOW UP ALL NON-RESPONDERS AT LEAST ONCE

In leprosy surveys, leprosy patients may be deliberately elusive and not attend, thus giving a low prevalence. Conversely, people may only attend a survey if they think there is something to be gained, as in malnutrition surveys leading to free food supplements. Those who are not seen may be as important as those who are seen. In surveys of common conditions this non-response may not be as critical as it is with some of the rare diseases. The problems of poor sampling and poor response rates apply equally to all surveys.

To reduce the non-response rate it is necessary to:

- See at least 80% of the original sample.
- Follow up all non-responders at least once.

7.7 Accuracy of measurements

Measurements can easily be inaccurate. This is commonly because the survey worker makes a faulty measurement, and not because of faulty instruments or unreliable subjects. This is known as **observer error**. There may, however, be instrument errors if they are not checked regularly, e.g. the adjustment of the zero reading on weighing scales. Another common source of error is faulty recording of information on the record forms or questionnaires.

Inaccuracies can be reduced by:

- Thoroughly training all staff and checking frequently to see that the methods are being carried out correctly.
- Following standard and agreed guidelines, e.g. how to weigh an infant; how to ask questions in a questionnaire.
- Using "blind" methods wherever possible. This means that the subject and/or the observer does not know important items of information that might encourage them to bias their answers or their techniques, e.g. the main purpose of the survey or whether a child is thought to be malnourished or not.

OBSERVERS AND INTERVIEWERS ARE THE MAIN SOURCE OF INACCURACIES AND ERRORS

- Survey workers should sign their name against any case history, physical examination, measurement or laboratory test, so that it is clear who did it. This encourages more accurate work and makes the checking of records much easier.
- Checking all instruments at least once per day using a known standard, e.g. infant weighing scales can be checked against a 10 kg weight.

7.8 Questionnaires

Questionnaires may look simple but in fact they are surprisingly difficult to design. They are used for collecting information, usually with an **interviewer**, about such items as what people have been doing in their recent past, what foods they eat, whether they have any illnesses, which people have died recently, and where they go to get medical help. Such information would be difficult or impossible

Figure 7.4. An interviewer administering a questionnaire to a family during a household survey

to get in any other way. For instance, it is easier to ask people where they get their domestic water than to observe them to find out. However, it must be remembered that such information is what people say they do, which might be quite different from what they actually do.

The following are some common problems with questionnaires:

- Poor questions, which are unclear, badly worded or which really contain more than one question. Each question must be simple, clear and non-threatening.
- Leading questions can influence responses. Questions should not suggest that a particular answer is correct.
- Sensitive and personal questions may produce evasive answers. Ask general questions first, then go on to more sensitive issues later.
- People may not remember events that occurred long ago. In general, a recall period of two weeks is the maximum that can be relied upon (except for major events such as death or admission to hospital).
- Interviewers left too free to interpret the subject's answers. Record directly what the subject says or use pre-coded answers.
- Too many questions, so that subjects and interviewers get bored. After basic questions on name, age, sex, etc., a further 10-15

questions allow for an interview lasting about 15-20 minutes, which means that three to four people can be interviewed in one hour.

- Use of inappropriate and non-standardized translations of questions into local languages. Many problems can arise when a questionnaire is constructed in one language but the questions are actually asked in a second language. This can be overcome by getting one group of people to translate the draft questionnaire and then for another group to translate it back again. This reveals discrepancies that arise during the translation, which can then be remedied.
- Subjects are usually worried about why the questions are being asked and who will be given the information. A reasonable and full explanation should be given by all interviewers, followed by a strong assurance as to the confidentiality of the respondent's name and the subsequent use of the information. People may be particularly worried about their name being passed on to other authorities.

PILOT-TEST ALL QUESTIONNAIRES

After being designed, it is vital for a questionnaire to be **pilot-tested** using interviewers and a small group of people for whom it is intended. This is essential to correct any mistakes or ambiguities and to train all interviewers in the new agreed version. Role-playing by the interviewers and interviews done under the critical eye of colleagues are two very useful means of obtaining a standardized technique by all the interviewers.

THOROUGHLY TRAIN AND SUPERVISE ALL INTERVIEWERS

Interviewers need to be aware of how they can influence the answers to questions, which should be asked in a neutral and non-threatening way and without any indication that certain answers are "correct." The interviewer should, therefore, not show agreement or disagreement or distaste or pleasure with the replies. This ability only comes with careful training. Health workers often make poor interviewers since they have difficulty in remaining neutral and in refraining from giving advice. For this reason, it may be better to recruit interviewers from among other groups of educated people such as teachers, extension workers or secondary school children rather than the district health staff. In many cultures it is very important, especially for sensitive subjects like family planning and childbirth practices, for women to interview women and men to interview men. The interviewer's sex can markedly influence the respondent's replies to questionnaires.

7.9 Variables

Choice of variables

Variables are characteristics that are measured either numerically (e.g. age) or in categories (e.g. absence or presence of disease). The observations for each variable must be reproducible for them to be useful and considerable time should be spent during the planning stage of a survey to ensure that **standardized methods** are used in measuring and categorizing all variables.

Which variables should be included in a study? Obviously the selection should be based upon their relevance. If a variable is of no use in the subsequent analysis, then it should not be included. Be quite clear what information you hope to obtain before including a particular variable, because considerable effort and manpower could be needed to collect and process the extra data. Each item to be included in your survey must be justified and made to "pay its own way". When considering which variables to include in the study, the answer is as many as necessary but as few as possible!

On the other hand it is a mistake to limit the number of variables so that it is impossible to analyse certain aspects of the survey because relevant information was not collected in the first instance. As a routine, therefore, you should first produce a comprehensive list of all the variables that you think would be required for the study and then go through each item, in detail, to see how the information you wish to collect for that particular variable may be used in your ultimate data analysis. At this stage it is useful to draw up dummy tables that will be required in the analysis (see Section 7.3).

Measuring variables

Once the variables have been chosen, the next step is to plan how to measure them under field conditions.

There are two requirements for every variable:

- A good definition.
- A method of measuring it.

Illness has different meanings for different people. For example, what you call a "common cold" may be interpreted as "influenza" by someone else. Such differences in perception can lead to situations where the measurement of variables by different people will produce different results, i.e. the findings are not **repeatable**.

It is necessary, therefore, to define all variables clearly and by a method that permits them to be objectively measured. For example, malaria could be defined as the presence of *Plasmodium* parasites in the blood stream of a patient as identified from a single thick blood film, or as a child with splenomegaly, or as a fever with chills, or a combination of these. This is the **operational definition**. In formulating the operational definition of variables one must always keep in mind that only simple and limited, standardized techniques can be applied on a mass scale. More detailed examination techniques, such as those that are available in hospitals, are often not practical. It has to be accepted that such simplified techniques might miss a small percentage of cases or include non-cases, but it is just as important to ensure that your findings are repeatable.

In choosing the methods by which the variables can be measured, two facets should be considered. These are the precision or **repeatability** and the **validity** of the measurement.

7.10 Repeatability

Even the simplest measurements have their errors, sometimes to a surprising degree. The variations caused by experimental errors, including those related to test performance, determine the repeatability of the measurement, whereas those that are inherent in the method itself determine its validity. Thus it is possible to have a method which gives highly repeatable results that are not valid.

The repeatability of a measure is its ability to reproduce consistently the same information when repeated examinations of the same population are made.

The more reliable the method, the more repeatable the data are likely to be. If the variability in a method leads to random fluctuations in values above and below the true mean value, a relationship that actually exists may be missed, but false conclusions about a relationship will not occur. On the other hand if there is a consistent over- or underestimate of the true value, called a **bias**, faulty conclusions are likely since readings will be consistently lower or consistently higher than they should be.

The repeatability of a measurement can be affected by:

- Observer variation. This can occur in observations made by a single person (intra-observer variation) or by different people (inter-observer variation). An example of this is the variation in the ability of technicians to determine the presence of malaria parasites in the same blood slides.
- Subject variation. For example, the response to a question may be affected by the subject's motivations and beliefs and the place of the interview.
- Instrument and method variation. Some are obviously more reliable than others.

7.11 Validity

Validity refers to the extent to which the test is capable of correctly diagnosing the presence or absence of the condition or disease concerned.

The strict definition of a case of the disease or event under study is of utmost importance in obtaining a high validity because words may have different meanings for different people. An accurate diagnosis is as important to epidemiologists as it is to clinicians. But the clinician's task is to answer the question: "What condition does this patient have?" A clinician is free to perform additional tests until the proper diagnosis becomes clear. By contrast the epidemiologist has to preselect the diagnostic criteria to answer the question: "Does this individual in my population sample have the condition I am studying or not?"

The diagnostic criteria the epidemiologist uses may require standardized interviews, physical examinations, laboratory examinations, as well as such examinations as radiography (tuberculosis), electrocardiography (Chagas disease), slit lamp examinations of the eye (onchocerciasis), sonography (of the liver and spleen in malaria and schistosomiasis) and histopathology (leprosy). In the selection of the **diagnostic criteria** to be used, the epidemiologist has to consider the accuracy or validity of all the different methods.

There are two important aspects of validity, referred to as the **sensitivity** and **specificity** of the test. For example, a test is said to have a sensitivity of 90% if it correctly gives a positive result in 90% of people who actually have the disease. On the other hand, a test is said to have a specificity of 90% if it correctly gives a negative result in 90% of people who do not have the disease.

The **predictive value** of a test, which depends upon the disease's prevalence as well as on the sensitivity and specificity of the test, is the most important measure for determining the test's usefulness under field conditions. The positive predictive value measures the likelihood that a test-positive person actually has the disease.

Neglecting **cultural factors** may have a considerable effect on the validity of a questionnaire in surveys and may lead to wrong conclusions about the frequency and distribution of the variable. For example, consider the following survey of two villages in an area endemic for schistosomiasis. A urine sample was examined for eggs of S. haematobium and the questionnaire asked: "Do you have blood in your urine?" In the first of the two villages surveyed this question was considered offensive by the women, leading to marked underreporting by them compared with the results of the parasitological urine examinations carried out at the same time. In the second village, where no such taboos existed, there was good agreement between the interview results for both men and women on the one hand and the urine examinations for eggs on the other. Without the knowledge provided by the laboratory test, the questionnaire results might have led to the conclusion that schistosomiasis in the first village was more common in men than women. This example demonstrates the importance of checking the validity of all questionnaires.

Repeatability, validity and predictive value are considered in more detail in Appendix 5, page 189.

7.12 Ethical issues

These can play a very important part in deciding whether to undertake a survey or not. However, most of the major issues concern full-scale research studies; surveys undertaken as a part of the

work of the district health services would be viewed less rigorously. A much more detailed consideration of the issues is given in Appendix 1, page 169.

In many developing countries where health care services are limited, the population quite reasonably will expect some help with its own health problems. **Some service should be a part of any survey** and people found to be suffering from a disease or known not to have received a preventive health measure, such as immunization, should be treated or referred to a clinic.

Figure 7.5. No survey without health care

Another issue concerns **informed consent**. Each individual included in the survey should have been informed about its purpose and have given his or her consent to being included, even though this may be difficult to organize. Particular care should be taken when a potentially harmful procedure is used, such as a drug with dangerous side-effects. Provided the survey procedures are well established, it is common practice first to brief community leaders and local organizations and to follow this by some kind of general

announcement that allows individuals to withdraw if they wish. Ideally at the time of being seen, each individual should be given a full explanation and then asked to sign a declaration to say that he or she agrees to being included in the survey. However, in many cultures people would be very reluctant to give such written consent.

The next issue concerns **confidentiality**. All information is given in confidence and it should not be possible to identify any individual in the analysis or in subsequent reports. In addition, no information about any individuals contained in the records should be passed on to other people or organizations without the subject's consent.

CONFIDENTIALITY IS VERY IMPORTANT

In order to overcome some of these difficult ethical issues, it would be wise to discuss the survey with other senior district officers, community leaders and district health workers and to seek their comments, advice and permission.

7.13 District survey methods checklist

In order to avoid problems in carrying out surveys or in interpreting the findings, particular attention should be given to the need for:

- Clear, quantified objectives.
- Good definition of cases and events.
- Proper sampling procedures and adequate sample size.
- Low non-response and refusal rates.
- Avoiding bias by using standardized techniques and good equipment.
- Well designed and translated questionnaires.
- Well trained and supervised interviewers.
- Good pilot trials of methods, questionnaires and equipment.
- Using the same methods throughout the survey.
- Good communications with the population on consent and confidentiality.

The most serious fault, however, often lies with the people who carry out surveys because frequently the findings are never publicized or used in health planning. So why was the survey done at all?

CHAPTER 8
Organizing Investigations and Surveys

8.1 *Preliminary plans*

The organization of epidemiological investigations and surveys is complicated and needs careful planning and much more time than might be expected. If the organization proves too difficult and the proposed investigation or survey is thought to be unfeasible, some changes may have to be introduced, such as a reduction in the sample size or omission of particular questions or tests. A pilot trial is essential for testing the methods and the organization of the fieldwork. A more detailed and practical guide to organization is given in Appendix 4, page 179, which should be read by all district staff who will be responsible for organizing such field investigations.

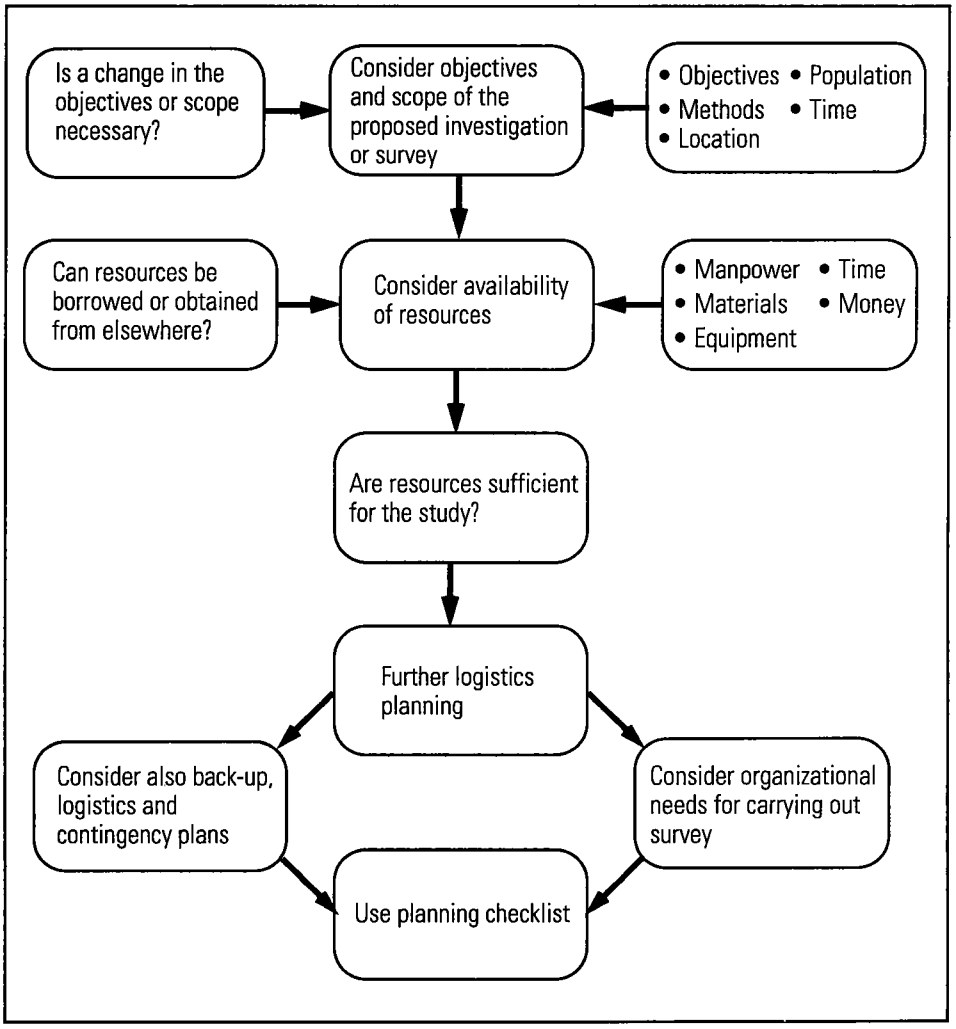
The survey organization should cover such details as:

- Personnel – number of workers and skills required.
- Materials – records, questionnaires and equipment.
- Finance – purchases, salaries and allowances.
- Time – preliminary organization, fieldwork and analysis.

An outline of the necessary preliminary steps is illustrated in Figure 8.1 and a suggested timetable is shown in Figure 8.2.

The number and type of **personnel** required depends on the duties that have to be carried out, e.g. professional, technical or administrative. An analysis of the tasks to be undertaken for the survey is essential and an estimate of the minimum educational levels required for each job is useful in recruiting staff. As women in some communities live in a secluded manner and male staff are not permitted to enter compounds or talk directly to women, female interviewing staff may be essential. Although a husband may answer

Figure 8.1. Preliminary steps in organizing epidemiological investigations



A PILOT TRIAL IS ESSENTIAL FOR ALL STAFF, METHODS AND EQUIPMENT

questions for his wife, the answers could be very misleading. Sufficient numbers of staff are required if the survey is to be completed in a reasonable length of time.

The amount of **materials** required also depends upon the nature of the survey. It is wise to estimate the minimum amount required and then to top this up with extras to allow for unforeseen developments or for underestimation.

Finances are usually required for such items as salaries, overnight allowances, accommodation, food and petrol, or for unforeseen needs such as new equipment, spares or additional transport.

Once the preliminary planning has been done and the different stages identified, the **time** needed to complete each stage should be estimated (see Figure 8.2). This will give an indication of the total time required. A pilot trial at this stage is essential.

The dates for the actual **fieldwork** will have to be fixed some time in advance. The time required for **preparations** and **pilot-testing** may

overlap with **training**, but all three must be completed in time for the fieldwork. Similarly, **analysis** and **consultations** should be completed before the **final report** is produced.

Figure 8.2. Example of organizational plan and timetable for proposed survey

	January				*February*				*March*			
Week	1	2	3	4	1	2	3	4	1	2	3	4
1. Preparation of sample, forms and questionnaire												
Obtain staff and equipment	2 weeks											
2. Pilot-testing of methods and all equipment			1 week									
3. Training of staff				1 week								
4. Fieldwork					2 weeks							
5. Analysis							2 weeks					
6. Consultation on findings									1 week			
7. Final writing and distribution of report										1 week		
Total time required												**10 weeks**

8.2 *Organizing the fieldwork*

If the investigation or survey involves a series of different measurements on each selected individual who attends a **survey centre**, it is important to break the work up into stages that can be handled by different staff. An example of a nutritional survey of young children is shown in Figure 8.3. The sections on the record form should be in the same sequence as the different stations (numbered 1 to 7) in order to avoid confusion. Also, to avoid observer bias each assistant should obtain information or take measurements before being able to look at the rest of the record form. If the assistants see the form first they will be tempted to write down information that "fits well" with what is in the other sections. Each assistant should sign his or her portion of the form in order to make supervision and correction of faults easy and to reduce observer errors during the survey.

If the investigation is a **household survey**, it is important to be realistic about the number of households that an interviewer can visit in one day. Remember that it is comparatively easy to see the first respondents, but the difficulty comes when chasing up the non-responders. This can require much staff time and effort. With a household visit and interview that takes 30-45 minutes per house, it is realistic for an interviewer to visit 5-7 households in one day. When following up on non-responders, even fewer households may be seen in one day by one interviewer.

Figure 8.3. Example of organizational plan for a survey centre carrying out a nutritional survey

	Start
Station 1 *(2 assistants)*	Registration and identification of individual on sample list and allocation of survey identification number.
Station 2 *(1 assistant)*	Entering of name, address and other information on record forms; labelling of specimen containers.
Station 3 *(2 assistants)*	Interview of patients, assessment of age and completion of health questionnaire.
Station 4 *(1 assistant)*	Measurement of height, weight and arm circumference; eye test.
Station 5 *(1 physician, 1 nurse)*	Physical examination and recording of signs of malnutrition.
Station 6 *(1 assistant)*	Specimens taken for laboratory tests.
Station 7 *(1 medical assistant)*	Dispensary clinic for treatment and drugs. Check subject's form is fully completed before saying thank you and goodbye.
	Finish

8.3 *Logistics and support*

A full checklist of logistic and support items is given in Figure 8.4 and what follows is a brief summary. For more details refer to Appendix 4, page 179.

Transport is usually essential in most developing countries. Transporting people and equipment by road, water or air will require careful planning. Allow extra time for mishaps and pack all equipment very carefully. If possible, have back-up transport in case of emergencies.

Specimens for laboratory investigation may require special containers, labelling, storage and transport. A **cold chain** is needed for biological reagents, such as vaccines.

Accommodation and cooking facilities need to be arranged in advance and employing a cook will save on staff time. **Food** may need careful storage and cooking in order to avoid contamination. Water for drinking may need to be purified, filtered or boiled. Facilities for **refuse disposal and toilets** may also be needed if survey staff stay in rural areas.

Loss of **stores and supplies,** particularly due to theft, can be a major problem. It is best to appoint one staff member as storekeeper, so that he or she alone is in charge of stores and issuing of items.

Good **financial management** is essential for staff morale. Salaries and allowances need to be paid on time, and petty cash should be available. A detailed record of expenditure is necessary, together with receipts, as the most senior staff member will have to account for all funds issued and spent.

Figure 8.4. Survey planning checklist

1. **Proposed study**
   - Title
   - Type
   - Duration
   - Location
   - Person in charge
   - Contacts
2. **Clearances**
   - Local authority
   - Police
   - Government
   - Higher authority
3. **Location**
   - Climate
   - Geographical features
   - Maps
   - Road conditions
   - River conditions
   - Airstrips
4. **Data collection**
   - Type
   - Regularity
   - Timing
5. **Staff requirements**
   - Functional categories
   - Number
   - Existing/new staff
6. **Accommodation**
   - Location
   - Survey team
   - Support group
   - Females/males
   - Tents
   - Electricity
   - Water
7. **Supplies**
   - Immediate
   - Replenishments
   - Stockpile
   - Order/indents
   - Food/cooking
   - Water/purification
   - Petrol
8. **Transportation**
   - Vehicles, bicycles
   - Boats
   - Aircraft
   - Maintenance
   - Tools
   - Spares
9. **Equipment**
   - Survey equipment
   - Stationery
   - Chemicals
   - Generator
   - Waterproofing
   - Other equipment
10. **Specimens**
    - Reception
    - Pick-up schedules
    - Refrigeration
    - Containers
    - Instruction slips
11. **Special points**
    - Emergencies
    - Back-up
    - Communications
    - Medical care for staff
    - Medicines and drugs
    - Records
    - Photographic eqipment
    - Tape recorders

8.4 District investigation and survey organization checklist

The following activities are listed in the order in which they might be done:

- Planning:
  - Decide why survey results are needed and how they will be useful.
  - Consult people with the relevant experience in local district government, community leaders and health workers.
  - Visit local villages to discuss the survey and hear comments from the people about their culture and local environment.
  - Decide which observations and measurements are needed and standardize the techniques.
  - Choose an appropriate population sample.
  - Design and pilot-test record forms and questionnaires.
  - Make arrangements for staff, equipment, transport, finance, accommodation, etc.
- Organization:
  - Obtain cooperation from local leaders.
  - Train survey staff.
  - Arrange for laboratory procedures.
  - Draw up a daily work plan for all staff.
  - Pilot-test all organizational details, including staff, methods and equipment.
- During the fieldwork:
  - Supervise all staff to ensure a high standard.
  - Ask local leaders to help with organization and checking for attenders and non-responders.
  - Make random checks on staff at the survey centre or interviewers during household visits.
- Analysis and communications:
  - Analyse the data as soon as possible, preferably daily.
  - Discuss results and their meaning with health workers and community leaders to obtain their comments.
  - Write report, incorporating comments, and make recommendations for new or improved health programmes.
  - Distribute report and discuss recommendations with relevant local committees and organizations and with local media, if appropriate.
  - Plan to evaluate any changes introduced as a result of the survey, to estimate their effectiveness.

CHAPTER 9
Record Forms and Coding

9.1 *Use of forms*

Two types of forms may be used for the collection of information: one is given to the person, called the respondent, to complete by themselves and is known as a **self-administered questionnaire**. The other type requires an interviewer to ask for the information from the respondent and is called a **record form** or **questionnaire**. Which approach is used depends, to a large extent, on the literacy of individuals. In many developing countries interviewers are used much more frequently than self-administered questionnaires.

Epidemiology often uses information from several different sources, such as clinic registers (e.g. outpatient and mother and child health clinics), lists of patients under treatment (e.g. in tuberculosis and leprosy), records of special investigations undertaken (e.g. chest X-rays, blood-slides examined), or special registers set up to collect information on a particular disease (e.g. registers for cases of cancer, malaria or trypanosomiasis). However, in district epidemiology it is important to assemble all the information on each of the individuals concerned on one record form. This is particularly true for special investigations or surveys.

Record forms often contain four kinds of data:

- Basic or preliminary data, including identification.
- Questionnaire information.
- Results of physical or medical examination.
- Information from special investigations.

9.2 Design of forms

Designing forms is not easy. Care should be taken to ensure that all relevant information is included while at the same time all repetitions and irrelevancies are left out. The form should be clearly laid out in a sensible, stepwise manner, keeping in mind the educational background of both the interviewers and respondents. Before a survey can be undertaken, therefore, careful planning of the survey forms is necessary and pilot-testing is essential.

When designing record forms four main rules need to be followed:

- A separate form should be used for recording information on each individual to facilitate analysis.
- All the required information must be clearly requested on the form.
- The form must be easy to use and clearly laid out, with each section in its proper sequence.
- Each form should be laid out to make data processing and analysis easy.

In addition to the questionnaire, a set of instructions is necessary for the interviewer to refer to if and when a problem arises. This is particularly necessary for interviewers who may be working on their own and far away from the supervisor. Clear instructions also help to avoid coding problems.

Some guidelines on the design of record forms:

- Avoid the use of very lengthy forms. Much time and energy is wasted in collecting information that has no relevance to the objectives of the survey. Furthermore, a lengthy form with too many questions can be annoying to the respondents, who are under no obligation to participate in the survey.
- Arrange the questions in order of difficulty. It is wise to save difficult or embarrassing questions for the end, when the interviewer should have established a closer rapport with the respondent.

ONLY ONE INDIVIDUAL PER FORM AND ALL INFORMATION ON ONE FORM

- Phrase questions in clear and simple language. Avoid the use of technical or ambiguous terms. Try to phrase questions in such a way that they will sound as though the interviewer is having a conversation rather than conducting an interrogation.
- Make sure that respondents can answer your questions. There is no point in asking questions on matters that are outside the respondent's experience or that occurred too long ago to be properly remembered.

Figure 9.1. Example of the first page of a precoded record form used in Malaysia

COMMUNITY HEALTH SURVEY OF VILLAGE

(PERIOD: 1 April to 30 April 1988)

Date of interview: ___/___/___ Interviewer: _____

INSTRUCTIONS: Fill in all the blank spaces
Circle the appropriate answer in sections E-H
Do not omit any item of information
Do not fill in the boxes in the coding column

		Coding column
Village: _____ (1)	House no: _____ (2,3,4)	❑❑❑❑ 1 2 3 4
Household no: _____ (5)	Individual no: _____ (6,7)	❑❑❑ 5 6 7

PERSONAL PARTICULARS

A *Name:* _____

B *Address:* _____

C *Sex:* 1 Male 2 Female ❑ 8

D *Date of birth:* _____/_____/_____
Day Month Year

Age last birthday (calculated from date of birth): _____ ❑❑ 9 10

E *Present marital status:* 1 Not married 2 Married 3 Widowed 4 Divorced/separated 5 Other (specify) _____ ❑ 11

F *Ethnic group:* 1 Malay 2 Chinese 3 Indian/Pakistani 4 Other (specify) _____ ❑ 12

G *Place of birth:* 1 Malaysia 2 Singapore 3 Indonesia 4 China 5 India/Pakistan 6 Other (specify) _____ ❑ 13

H *Religion:* 1 None 2 Islam 3 Christianity 4 Ancestral 5 Buddhism 6 Hinduism 7 Other (specify) _____ ❑ 14

9.3 Coding of information

Although the use of **precoded answers** is not necessary for all surveys, processing of data (see next chapter) can be made easier if the answers have been numerically coded. Coding consists of assigning a numerical value or code to a specific item of information. For example, we may use the numerical value 1 to denote a "Yes" answer for a particular question and 2 to denote a "No" answer for the same question. There is no hard and fast rule on the choice of numerical codes. However, standard replies like "Yes", "No", "Don't know", and "Not known" should preferably have the same codes throughout the recording form, to avoid confusion and errors in the analysis stage.

As an example, the different categories for the usual source of drinking-water may be numerically coded as follows:

1__ tap in house	6__ spring, river or lake
2__ tap or pump in yard	7__ other sources—specify
3__ tap or pump in public place	8__ (not used for a code)
4__ open well	9__ unknown
5__ rainwater	

It is useful to provide a category labelled "others" which can be used for all those answers that do not fit into one of the precoded categories. The interviewer should be instructed to write down, or specify, these "other" answers so that they can be analysed later.

When the information is numerically coded, it is preferable to have a single-digit code for each item of information as this makes the data processing easier, particularly when manual techniques are used. However, coding for exact age is a typical example where a two-digit code is needed. If a 75-year-old man has to be coded 75, a 6-year-old girl has to be coded 06. Exact age should be collected if possible, not just the age group. This makes analysis more flexible and permits the selection of particular individuals in the sample, such as women aged 15-44 years or children below 5 years old.

PILOT-TEST ALL QUESTIONS AND ANSWERS BEFORE USE IN SURVEYS

Alternatively, ages can be grouped into 5-year intervals such as 0-4, 5-9, 10-14, 15-19 and so on. The age group 10-14, for example, will comprise all children from 10 years to just below 15 years. Children less than 1 year old are often separated from the 1-4 year group, particularly in countries with high infant mortality. Larger age intervals are also used, e.g. 15-44-year-old females for the reproductive age interval and 60 years and above for old people.

9.4 Individual number

The individual's **survey number** depends on the sample size used. If this does not exceed 99, the first individual is given the number 01 and the ninety-ninth the number 99. The number can be more

complex. For example, in a large-scale survey involving randomly selected clusters of villages, it may be necessary (as in Figure 9.1) to identify a person by his or her village, house and household using a series of codes:

INDIVIDUAL SURVEY NUMBERS HELP TRACE PEOPLE

_	_ _ _	_	_ _
1	2 3 4	5	6 7
Village	House	Household	Person

The first digit is used to identify the village in which the person lives, the next three digits for the house, the fifth digit for the household should there be more than one household in that house. The sixth and seventh digits give the identification number of the person. A serial number like 3-126-2-08 is used to reference the eighth person belonging to the second household of house number 126 in village 3. Serial numbers can be very useful for tracing individuals.

9.5 *Layout of record forms*

In the design of a record form, there is a variety of formats to choose from. The precoded answers to a question like "How many living children do you have?" can be arranged as shown:

0__	None	5__	5 children
1__	1 child	6__	6 children
2__	2 children	7__	7 children
3__	3 children	8__	8 or more children
4__	4 children	9__	Unknown

Using a tick (✓) or a cross (✗) in boxes makes the coding of the information neat and easy. However, in the absence of boxes, the numerical code for the appropriate category should be circled as shown below.

To reduce space on the form the replies can be rearranged on one or two lines:

Number of children:

0 (none) 1 2 (3) 4 5 6 7 8 or more 9 (unknown).

9.6 *Coding column*

Provision is usually made for a coding column on the right-hand margin of the form, where the appropriate numerical code is entered (see Figure 9.1). The purpose is to facilitate data processing, particularly when the data have to be punched on to punch cards or entered directly into a computer. Once the coding boxes within the coding column are filled, processing of the data can proceed efficiently and speedily simply by sorting the numbers in the appropriate boxes in the column without referring to the answers themselves.

It is easy to make mistakes in transferring the precoded information from the question to the appropriate coding box in the coding column. For this reason, it is common practice to fill in the coding column after the interviews have been completed, when the coding can be done at a more leisurely pace. This coding should be done by only one or two people and each coding should be double-checked by another person to make sure it is correct. Coding errors need to be corrected before the analysis is started.

CHAPTER 10
Data Processing and Analysis

10.1 Processing and analysis

Data only become really useful when they have been processed and analysed. Health data may come from routine information systems, surveillance systems, investigation of epidemics or special surveys.

Once the data have been collected and coded, the next step is to process them to provide information on all the important questions or variables. **Data processing** within districts will probably be undertaken by hand-tallying, hand-sorting or microcomputing.

For simple descriptive epidemiological data on up to 300 individuals, data processing and analysis can be done easily, and quite quickly, by two or three people using hand-tallying and/or hand-sorting. Two advantages of these methods are that recording and coding mistakes can be corrected immediately and that they give a very good "feel" for the data and their meaning. After the initial tallying, the totals, percentages and rates can easily be calculated using a small electronic calculator. The use of microcomputers, with the coded data entered directly via the keyboard, is recommended only for large and complicated surveys. Many developing countries are introducing the use of microcomputers for handling health information, but as yet few have good and reliable microcomputing facilities for district health teams. Edge punch cards used to be popular but they are now rarely recommended because microcomputers have largely taken their place.

10.2 Hand-tallying and sorting

Hand-tallying involves counting the number of times a particular category of information appears in all the record forms. If the data have not been pre-coded, all the possible answers must first be listed. For example, when processing data on the symptoms reported for a particular disease, first list all the possible symptoms and then go through all the record forms. As a particular symptom is encountered, count it or record it by making a vertical mark against that particular symptom on the tally sheet thus:

Figure 10.1. Example of a tally sheet

Symptoms	*Tally*	*Total*
Nausea	//	2
Diarrhoea	𝍸 //	7
Constipation	𝍸 𝍸 /	11
Arthralgia	𝍸 /	6

For easy counting, every fifth mark is drawn diagonally across the preceding four marks to produce the notation (𝍸), which indicates a group of five items. In the example just given, we can quite readily see the totals for each symptom.

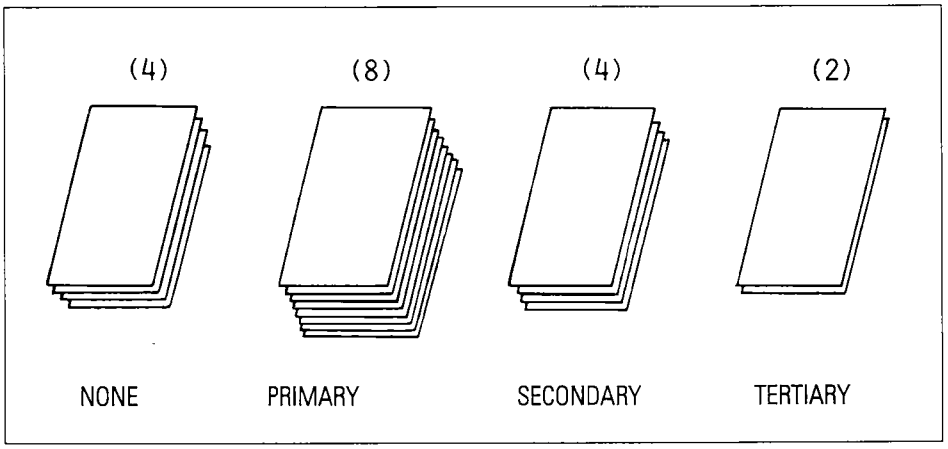
When the number of forms to be analysed is larger than about 100, tallying becomes prone to error, often as a result of fatigue on the part of the person doing it. Common errors in tallying include the misclassification of an item, e.g. "nausea" when it should be diarrhoea; double-counting an item or missing one altogether. The risk of errors is higher when tallying for a two-way tabulation, as in Figure 10.2:

Figure 10.2. Hand-tallying for a two-way table, showing the age and birth order of children

	Birth order of child					
Age (years)	*1*	*2*	*3*	*4*	*5 or more*	*Total*
0-4	𝍸	𝍸 /		///		14
5-9	/		𝍸 //		///	11
10-14		/		//		3
15-19			///	𝍸	//	10
20-24	𝍸 𝍸 /	//	////	/		18
Total	17	9	14	11	5	56

Hand-sorting is similar to tallying in that counts are made of specific items of information as they appear on the record form. In hand-sorting, the first step is to decide on the different levels and then to sort all the record forms according to the item of information and count the total in each pile. The totals for all piles should add up to the total number of forms being analysed. An example for highest educational level achieved is shown in Figure 10.3.

Figure 10.3. Hand-sorting forms by highest educational level achieved



Like tallying, this procedure is susceptible to errors. However, unlike tallying, errors arising from misclassification can be more easily checked and rectified. For example, if in checking the pile for primary level, we come across a secondary level form, all we need to do is to transfer it to the "secondary" pile. Hand-sorting can be a tedious procedure, particularly if the sample size is over 100 individuals.

10.3 Steps in data analysis

When the data are processed, each variable (or question) for each subject can be counted and these counts summarized as tables. Graphs and diagrams cannot be drawn without the use of tables.

The main set of tables for the expected end results (called "dummy" tables) should have been developed early on in the investigation when the objectives of the study were agreed upon (see Section 7.3 on survey objectives). These dummy tables act as a guide in the analysis, and may be reviewed and modified as the analysis progresses.

When constructing tables three conditions must be satisfied:

- All data should be in a form that can be classified into categories:

  e.g. spleen palpable: Yes or No
  age or haemoglobin: actual numbers or values.

- All table categories must be mutually exclusive
  i.e. no individual can be classified twice in one table.
- Each table should include all the "raw" data
  i.e. no individual can be left out of a table, except under special circumstances.

These conditions mean that if the observed value of a variable, such as age or haemoglobin, is entered directly on to the record forms, a classification must be designed before the analysis can take place. Where precoded categories are used, the classification obviously already exists. When designing a classification it is useful to remember that there must be at least two categories, but as a general rule there should not be more than 10.

Statistical analysis can involve complicated techniques. However, district epidemiology makes use of three separate stages in analysis that it is best to go through in sequence.

The three essential steps in data analysis are:

- Analyse each variable separately, one after the other, for the distribution of counts in each category. This is called **simple** or **one-way tabulation**. What do the distributions look like? What do they tell us?
- Analyse pairs of variables that are relevant, such as incidence of cases by age group, sex or month of the year. This is called **two-way** or **cross-tabulation**. Are there any findings or associations that stand out clearly?
- Calculate the appropriate means, percentages and standard deviations. These are called the **summary statistics**.

By the time these three stages of the analysis have been completed the person doing the analysis and the DHMT should have a good "feel" for the data. In drawing conclusions it is important to look for associations between variables and to check whether any apparent differences are real or not, that is whether they are significant or not. Tests of statistical significance may be needed at this stage, the results of which are commonly expressed in terms of the probability that such an association could have occurred by chance. Often an association is arbitrarily considered as significant if the probability *(P)* is less than 5% ($P < 0.05$), i.e., it would occur by chance less than 1 time in 20.

10.4 Simple tabulations

Table 10.1 shows a set of **raw data** obtained from a cross-sectional survey of a random sample of 100 villagers for haemoglobin levels and hookworm infection. Additional information was also collected on the age and sex of the villagers. This set of raw data will be used to illustrate the various kinds of statistical tables that can be constructed.

Table 10.1. Raw data on haemoglobin levels (grams per 100 ml) and hookworm infection (positive or negative) for 100 villagers, obtained by a cross-sectional survey of 10 randomly selected individuals in each of 10 randomly selected villages from the whole district

Individual	*Age (years)*	*Sex*	*Haemoglobin (g/100 ml)*	*Hookworm infection*
1	46	F	10.3	+
2	9	F	8.4	+
3	8	F	9.0	–
4	30	F	9.4	–
5	45	F	8.4	+
6	2	M	10.0	+
7	12	M	8.3	–
8	33	F	10.9	+
9	4	F	8.8	+
10	57	M	10.9	+
11	38	M	10.9	+
12	51	F	7.3	–
13	42	M	8.3	–
14	38	M	9.0	+
15	41	F	9.8	+
16	8	F	9.3	+
17	16	F	9.7	–
18	0	M	13.8	+
19	1	M	8.9	–
20	4	M	7.5	+
21	2	F	10.9	+
22	13	F	10.7	+
23	8	F	10.5	+
24	12	M	9.6	+
25	59	F	6.8	+
26	19	M	11.6	–
27	3	F	9.2	–
28	4	F	8.4	+
29	32	F	10.9	–
30	27	M	11.5	–
31	43	F	11.4	+
32	4	M	9.4	+
33	62	F	10.3	+
34	33	M	12.7	–

Table 10.1 (continued)

Individual	Age (years)	Sex	Haemoglobin (g/100 ml)	Hookworm infection
35	8	M	10.2	+
36	37	M	11.2	–
37	56	M	12.2	–
38	39	F	10.0	–
39	37	M	12.2	–
40	6	M	10.1	+
41	2	F	11.0	–
42	14	M	10.3	+
43	48	F	8.4	+
44	62	F	8.9	+
45	0	M	13.1	–
46	16	F	9.3	+
47	9	F	6.4	+
48	24	M	11.7	–
49	20	F	10.0	–
50	68	F	9.1	+
51	12	M	10.8	–
52	24	M	11.8	–
53	71	M	6.6	+
54	45	M	8.7	+
55	3	M	9.8	–
56	52	M	12.4	–
57	21	F	12.0	+
58	33	F	10.6	–
59	7	F	10.8	–
60	42	F	11.0	–
61	5	M	10.0	+
62	36	F	10.9	–
63	1	F	7.4	+
64	8	F	11.6	–
65	29	F	10.8	–
66	4	F	9.8	–
67	0	F	8.6	+
68	2	M	10.2	+
69	13	F	10.4	+
70	35	M	10.8	+

Table 10.1 (continued)

Individual	*Age (years)*	*Sex*	*Haemoglobin (g/100 ml)*	*Hookworm infection*
71	63	M	7.0	+
72	35	M	11.0	+
73	42	M	10.2	+
74	3	F	10.2	+
75	4	M	9.4	+
76	23	M	6.8	+
77	34	M	12.2	−
78	41	F	10.0	+
79	1	M	9.4	−
80	51	M	9.6	+
81	36	M	11.2	+
82	8	F	7.9	+
83	11	M	9.2	+
84	14	M	12.6	+
85	38	F	10.2	−
86	56	F	9.1	+
87	19	F	9.4	+
88	27	F	10.8	−
89	9	M	12.7	−
90	36	F	6.2	+
91	14	F	10.1	+
92	42	M	12.9	−
93	10	M	11.2	−
94	39	M	8.4	+
95	11	F	11.6	−
96	8	F	9.7	+
97	23	M	11.9	−
98	13	M	7.8	+
99	17	M	9.8	+
100	41	F	12.1	−

All tables must have a proper title which should be complete, concise and self-explanatory. The title should give information on the sample being analysed and on the variables being presented.

Table 10.2 shows the age distribution by broad age groups of the sample of 100 villagers. As the tabulation involves only one variable,

namely age, we have a **simple** or **one-way table**. In this example, age is treated as a discrete measurement and broad age groups have been used because the number of subjects is fairly small. To group the villagers, the two opposite extreme values are found from the set of raw data, (in this case, less than 1 year old and 71 years old). The first category in the table includes the smallest value and the last category the highest. Having obtained the classes, we can then process the raw data by hand tallying or sorting.

If a larger sample were being analysed, the use of a larger number of age classes might be necessary. In that case, the age groups might be: under 1 year old, 1-4, 5-14, 15-24, 25-34, 35-44, 45-54, 55-64 and 65+ years.

Table 10.2. Age distribution of the sample of 100 villagers

Age group (years)	*Number*
0-4	19
5-14	25
15-44	40
45+	16
Total	100

Table 10.3 shows the age and sex distribution of the sample of 100 villagers as an example of a **two-way table**. The age-sex distribution of the sample can now be compared to that for the district. If the two are similar, the sample is probably reasonably representative of the whole district population.

Table 10.3. Age and sex distribution of the sample of 100 villagers

Age group (years)	*Male*	*Female*	*Total*
0-4	10	9	19
5-14	12	13	25
15-44	20	20	40
45+	7	9	16
Total	49	51	100

For a continuous measurement variable, such as haemoglobin level, a simple tabulation starts by grouping the data in categories, as shown in Table 10.4.

Table 10.4. Distribution of haemoglobin levels in 100 villagers

Haemoglobin level (g/100 ml)	*Number of villagers*
6.0– 6.9	5
7.0– 7.9	6
8.0– 8.9	13
9.0– 9.9	22
10.0–10.9	29
11.0–11.9	14
12.0–12.9	9
13.0–13.9	2
Total	100

To make up the categories, the two extreme haemoglobin values (i.e. the lowest and highest) are first identified; the difference between them gives the range. In this example, the lowest reading in the sample is 6.2 and the highest 13.8; the range is therefore 7.6 grams/100 ml. The range is then divided by 10 to obtain a crude value for the class interval. (Since about 10 categories or groups usually gives a good distribution, dividing the range by 10 is a good starting point.) This would give an interval of about 0.8 g, but as a whole number is preferred, intervals of 1 g are used. If the number of categories is too small or too large, it may be difficult to make sense of the distribution of the variable.

10.5 Cross-tabulations

Cross-tabulations involve the use of at least two variables. In its simplest form, a cross-tabulation consists of 2 rows and 2 columns (excluding the row and column totals). Table 10.5 gives an example of a **two-by-two table**, which is often used when both variables are classified as "present" or "absent."

Table 10.5. The distribution of hookworm-infected subjects by haemoglobin levels of less or more than 10 g/100 ml.

Haemoglobin level	*Hookworm infection*		*Total*	*% with hookworm*
	present	*absent*		
Less than 10 g/100 ml	35	11	46	76.1%
10 g/100 ml or more	24	30	54	44.4%
Total	59	41	100	
% with anaemia	59.3%	26.8%		

A haemoglobin value of less than 10 g/100 ml can be used as an arbitrary cut-off point for the diagnosis of anaemia, which affected 46 out of the 100 villagers. Over half of the villagers, 59 in all, were found to be infected with hookworm. Of those villagers with hookworm infection, 59.3% were anaemic compared with 26.8% of those with no hookworm. A further analysis by age and sex could be made using the Chi Squared test, which is a useful test of statistical significance to apply to "2 by 2" tables. Use of the test on these data would show that in these villages anaemia was statistically associated with hookworm infection (P, or probability, <0.05).

Table 10.6 gives a further example of a cross-tabulation involving the two variables haemoglobin and sex, but this time with more than two categories for haemoglobin. The grouping of the data for haemoglobin has been done in the same manner as in the simple or one-way tabulation shown in Table 10.4.

An example of a **three-way tabulation** is illustrated by Table 10.7. The three-way table is constructed by processing all the data on the three variables, namely haemoglobin, age and sex, given in the set of raw data. From this three-way table, one-way or two-way tables can be obtained by looking at the totals. For example, in the three-way tabulation given in Table 10.7, the row totals give the simple tabulation for haemoglobin levels.

Table 10.6. Distribution of the 100 villagers by haemoglobin levels and sex

Haemoglobin level (g/100 ml)	*Sex*		*Total (both sexes)*
	Males	*Females*	
6.0– 6.9	2	3	5
7.0– 7.9	3	3	6
8.0– 8.9	6	7	13
9.0– 9.9	10	12	22
10.0–10.9	10	19	29
11.0–11.9	9	5	14
12.0–12.9	7	2	9
13.0–13.9	2	0	2
Total	49	51	100

Table 10.7. Distribution of the 100 villagers by age, sex and haemoglobin level

Haemoglobin level (g/100 ml)	*Age group (years)*								*Total*	
	0-4		*5-14*		*15-45*		*45+*			
	M	*F*	*M*	*F*	*M*	*F*	*M*	*F*	*M*	*F*
6.0	0	0	0	1	1	1	1	1	2	3
7.0	1	1	1	1	0	0	1	1	3	3
8.0	1	3	1	1	2	0	2	3	6	7
9.0	4	2	2	3	3	5	1	2	10	12
10.0	2	2	5	5	2	10	1	2	10	19
11.0	0	1	1	2	8	2	0	0	9	5
12.0	0	0	2	0	4	2	1	0	7	2
13.0	2	0	0	0	0	0	0	0	2	0
Total	10	9	12	13	20	20	7	9	49	51

10.6 Summarizing statistics

All the data on a variable can often be expressed in a much briefer way by using **summarizing statistics or indices.**

The most useful indices are:

- Percentage of subjects infected,

  e.g. schoolchildren infected with *S. haematobium* or malaria.

- Percentage of subjects above or below a certain cut-off point,

  e.g. adults with a systolic blood pressure of 160 mm Hg or more in hypertension and pregnant women attending antenatal clinic at least once.

- Mean and range. The average is another name for the mean and the range expresses the difference between the lowest and highest values in the raw data.

  e.g. mean birth weight and average number of visits made by children to child health clinics.

- Standard deviation (often called SD) can be used when there is a reasonably normal or bell-shaped distribution about the mean. (For an example see Figure 11.6.) The SD can easily be calculated using some scientific electronic calculators. A large SD indicates a wide scatter of individual values on either side of the mean or average while a small SD value indicates a narrow distribution of values.

  e.g. severe malnutrition defined as those children more than two SDs below standard weight-for-age;

  normal range for many laboratory tests is often expressed as the mean plus or minus 2 x SD.

10.7 Correlation

When two quantitative variables are associated or correlated with each other, an increase or decrease in one is associated with an increase or decrease in the other. For example, the newborn baby's weight is positively correlated with mother's weight and the proportion of children with lower than normal weight-for-age is often negatively correlated with family income.

Whenever there are two continuous variables, often measured on the same individuals, a very useful technique is to draw a scatter diagram, or scattergram, as shown in Figure 11.12. The more closely correlated the two variables are, the closer the dots will appear to be on a straight line. This correlation can also be calculated using statistical formulae and it is then expressed as a correlation coefficient.

Whenever two variables are thought to be correlated it does not necessarily mean that one variable is the cause of the other. Great care must be taken in interpreting the relationship between variables. For instance, a mother's height may partly determine the baby's weight but the reverse is biologically not true.

10.8 Standardization

To make comparisons, for example between the prevalence of malnutrition in the district 10 years ago and at present, or between disease prevalence rates in the district and in the country as a whole, it is necessary to **standardize** for the different populations. This avoids comparisons between two populations with different shaped population pyramids and age-sex distributions.

To handle increases in population size, we commonly use a percentage or a rate per 1000 people, which can be made more accurate by using an **age-, sex- and disease-specific percentage or rate**, e.g. 20% of male children 5-9 years old were infected with Bancroftian filariasis in 1986 compared with 10% in 1976.

Where the age-sex structure or pyramid of the district is noticeably different from the national one, statistical adjustments should be made before comparing district with national rates. A technique called **direct standardization** can be used to do this. The technique and an example are explained in Appendix 6, page 193. It is important to standardize for the age structure of the district population where a variable, such as the risk of death, is unevenly distributed according to age and for the sex structure where the variable, such as number of births, is associated with one sex. The crude death rate (CDR) could be much higher in one district because there is a higher percentage of children living (and dying) in that district compared with another one nearby. In this case comparing the CDRs for districts would not be valid; the same is true if the district rates for today are compared with those of 10 or 20 years ago. Further details on using disease-specific rates and direct standardization are given in Appendix 6.

CHAPTER 11
Presenting Health Information

11.1 Tables and figures

Tables are the essential means of presenting an organized set of analysed data, particularly numerical or quantitative data. Figures, graphs and maps are also frequently used because they can present visual information much more clearly than tables, for example when we want to show comparisons, patterns or time trends. Figures are also very useful for qualitative, or non-numerical, types of information.

The most frequently used methods for presenting health information are:

- Tables
- Graphs
- Histograms
- Bar charts
- Pie charts
- Scatter diagrams
- Maps

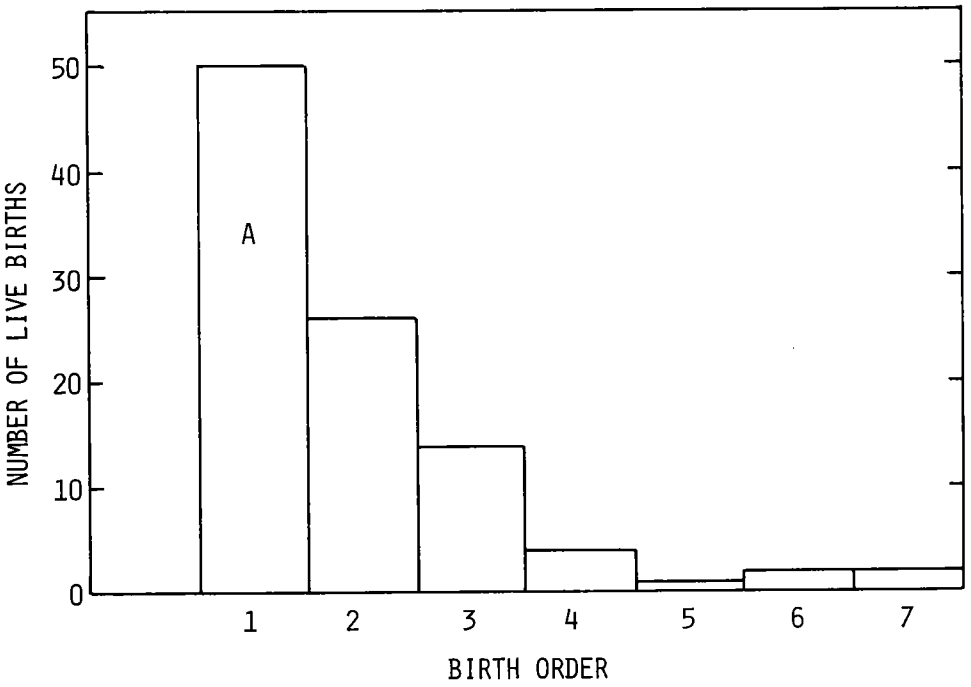
The following are some important points about using tables and figures.

Titles should always be concise and self-explanatory, expressing clearly all the information that is being presented. The meaning of the title should be immediately obvious to the reader, without having to refer to the text for an explanation. For example: "Prevalence rates by age for *Schistosoma haematobium* in five provinces of Zambia, 1980".

Rows and columns must be clearly labelled and, where appropriate, all the categories should be clearly shown. For examples, see Tables 10.2 and 10.5 on pages 106 and 108, respectively.

Axes of graphs and diagrams should be properly defined, and clearly labelled with their scales. The vertical axis of a graph is known as the Y-axis, or the ordinate, while the horizontal axis is known as the X-axis, or the abscissa. For example, in Figure 11.1 the horizontal axis shows birth order, beginning from a value of 1 and increasing by 1 until the highest recorded birth order in the sample is reached. The vertical axis shows the frequency of individuals, presented in intervals of 10 individuals. Thus the first bar (labelled A) of the diagram indicates that there were 50 individuals in the sample of infants that were of birth order 1 and only 5 were of birth order 5 or more.

Figure 11.1. Distribution of 100 consecutive live births by birth order



Keys or labels are necessary in graphs with more than one line, i.e. when information on more than one group is presented. The labels identify the different groups being presented for comparison (see Figure 11.2).

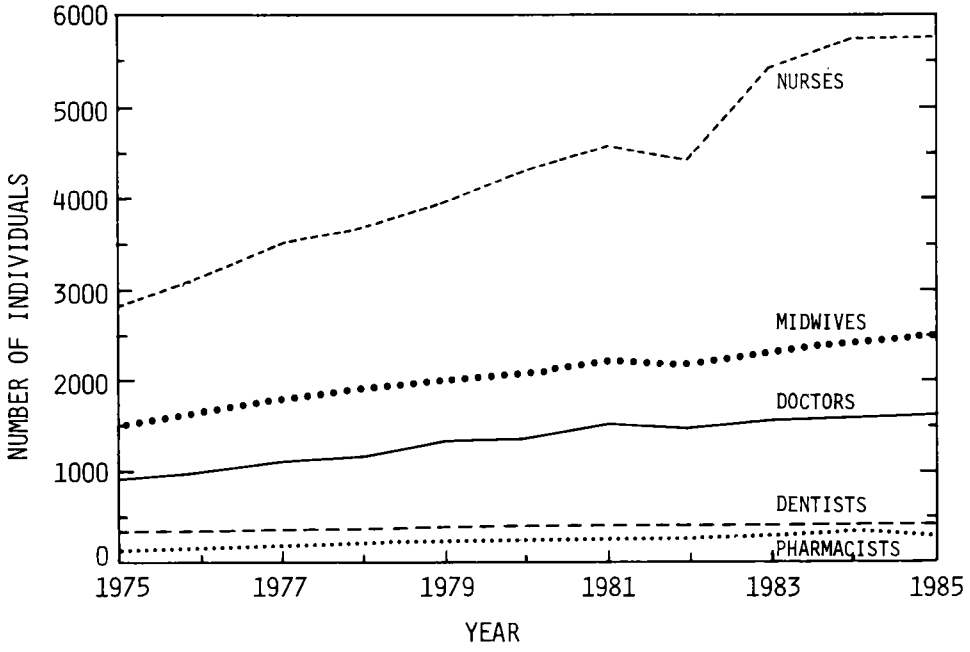
Footnotes are used to indicate the source of the original information. In reports it is quite common for a diagram or chart to be reproduced or adapted from another source to illustrate the issues being discussed.

11.2 Graphs

These are the most commonly used type of figure, particularly for showing numerical data such as deliveries per month, percentage of children immunized by year or number of new cases per month of a disease, such as trypanosomiasis or kala-azar.

Figure 11.2 shows a graph of time trends of the total number of different health workers over a 10-year period. These show that the number of nurses has increased most, from less than 3000 to nearly 6000, with midwives and doctors next. Note, however, that in percentage terms, the pharmacists have increased fastest, showing a nearly 3-fold growth from about 100 to nearly 300.

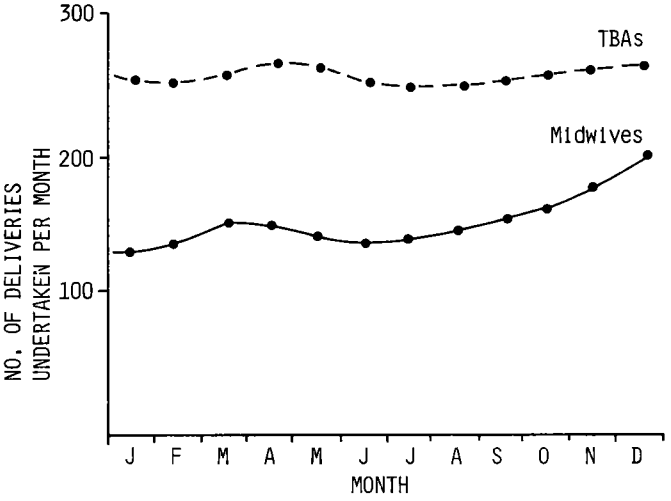
Figure 11.2. Growth in number of registered health workers, 1975-1985



Graphs are useful for showing two or more distributions, providing the difference between the lines is clearly shown. Figure 11.3 shows the number of mothers delivered each month in a district by trained traditional birth attendants (TBAs) during one year compared to the number delivered by professional midwives in the district health centres and hospitals. Assuming that there were a total of 9000 deliveries per year in the district (see Section 3.3), the trained TBAs supervised about 3000 or 33% and midwives a further 1900 or 21% of all deliveries between them; thus, 54% of all births were attended by a trained health worker. The graph also shows that the

number of deliveries undertaken by midwives each month rose towards the end of the year, whereas the number undertaken by TBAs remained fairly constant.

Figure 11.3. Number of reported deliveries undertaken each month by trained traditional birth attendants (TBAs) in homes and by nurse midwives in health centres and hospitals during 1986



How to draw a straight-line frequency graph

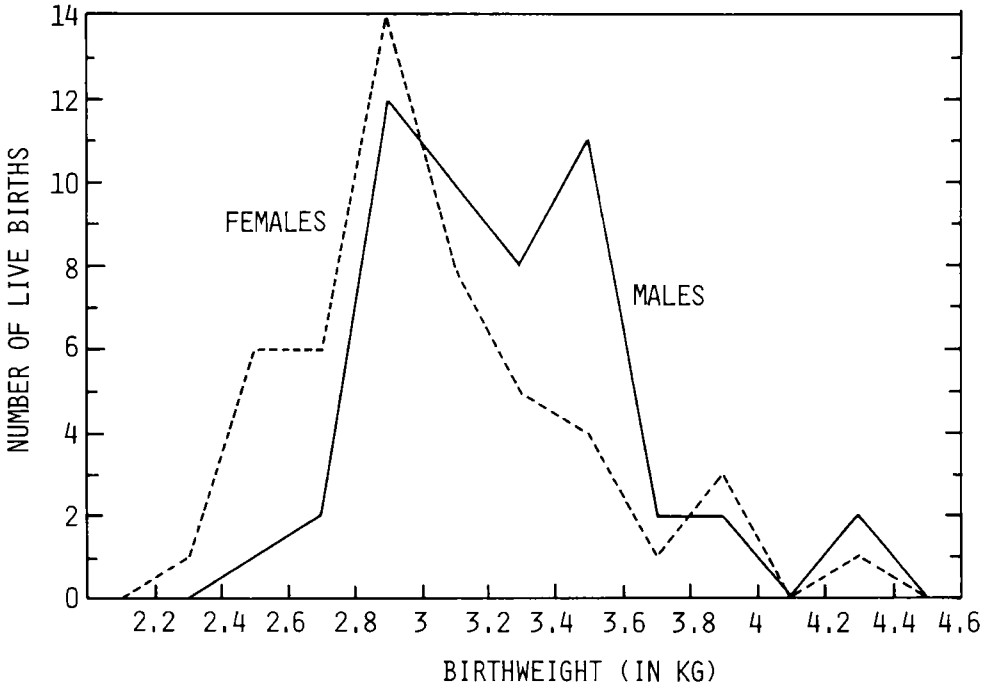
- Draw the horizontal axis (the X-axis). Mark off the scale using equal units. Use the mid-point of each interval to represent all measurements lying within that interval.
- Mark off the vertical axis to show the frequency, commonly as a number, percentage or rate.
- For each class of the grouped data mark a point where the vertical (frequency) and the horizontal (scale) values intersect.
- Join the marked points with straight lines. The lines can be extended beyond the first and last classes to touch the X-axis. This kind of graph is called a **frequency polygon**; an example is shown in Figure 11.4.

Graphs can be used effectively to compare two frequency distributions, e.g. birth weight by sex. Figure 11.4, for example, suggests that there were more low-birth-weight female than male babies.

Cumulative frequency graph

This graph expresses a cumulative distribution, often expressed as total numbers or as a percentage. This is a useful graph for showing progress in implementing a planned activity, such as immunizations.

Figure 11.4. Frequency distribution of 100 live births by sex and birth weight



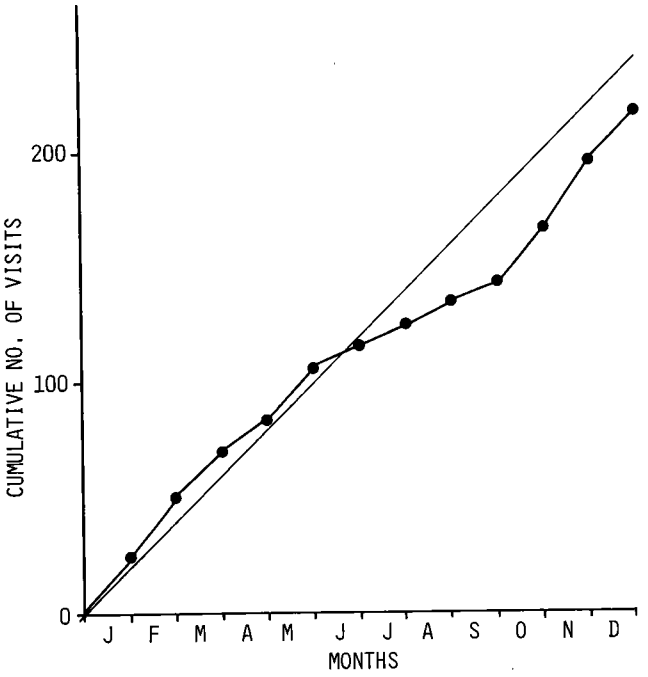
Since the frequencies are progressively accumulated, i.e. they always increase (or at least remain constant) over time, the cumulative frequency graph never dips downwards. If no occurrences are added to the cumulative frequency over a time interval, the graph line merely flattens out to give a plateau effect.

An example is given in Figure 11.5. Suppose a district has 40 community health workers (1 per 5000 people) and the DHMT has decided that they should be visited once every two months, making 20 visits to be undertaken per month and a total of 240 in one year. Figure 11.5 shows that the visits schedule started off well and then slowed down, but then a special effort was made to carry out more visits in order to catch up towards the end of the year.

How to draw a cumulative frequency graph

- Obtain a cumulative frequency distribution by adding the figure in each class of the frequency distribution to all the frequencies in all the preceding classes (for an example see Section 13.10).
- For each class, plot the cumulative frequency at the **end** of the class interval on the horizontal axis.
- Join the points with straight lines to produce the cumulative frequency graph.

Figure 11.5. Cumulative graph showing number of visits to community health workers by district headquarters staff



11.3 Frequency histograms

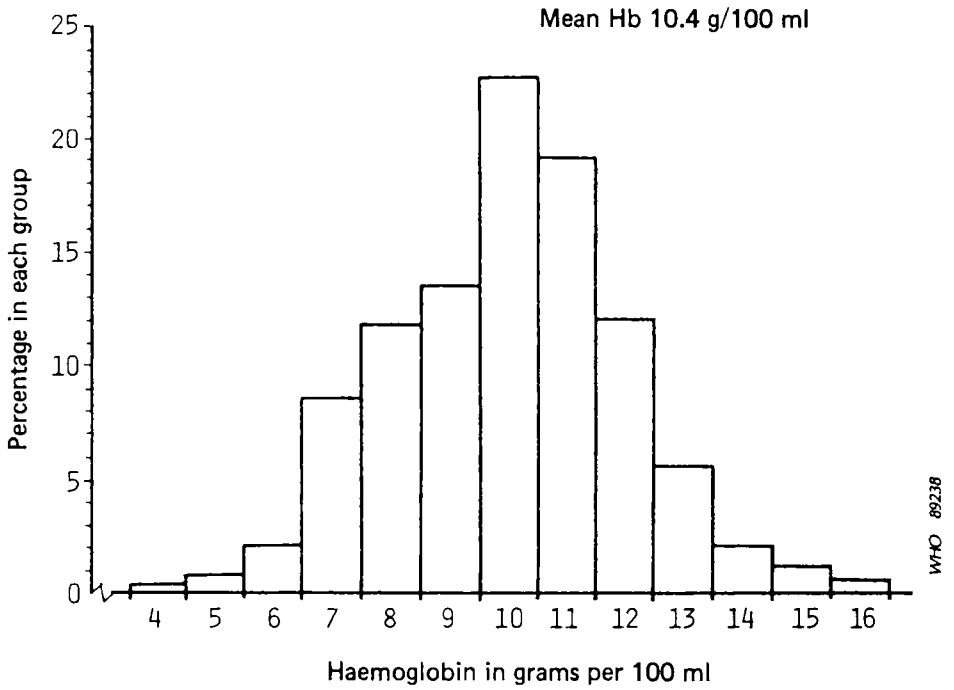
These diagrams are commonly used for presenting information. Figure 11.6 shows a typical frequency histogram. An important characteristic is that the bars of the histogram are contiguous, that is, one bar immediately follows another with no space between. This shows that the scale on the horizontal axis is a continuous measurement scale.

The shape of the distribution in Figure 11.6 is bell-shaped which is the sign of a **normal distribution**. With this type of distribution it is valid to calculate the **mean** and the **standard deviation** for all the individual haemoglobin values. For a one-sided distribution, such as that shown in Figure 11.1, it is valid to calculate the mean, but not the standard deviation (see also Section 10.6).

How to draw a frequency histogram

- The horizontal axis, the X-axis, gives a continuous scale of the measurement variable while the vertical axis, the Y-axis, shows the frequency.
- For each class of the grouped data, a bar or rectangle is drawn. The width of the bar is the same as the class interval used.

Figure 11.6. Histogram showing the distribution of haemoglobin levels for 1400 adult men and women



11.4 Bar charts

These resemble the frequency histograms in appearance, but they differ because the bars are not joined together, but separated by a space. This diagrammatic arrangement is used when the horizontal axis deals with information that is qualitative or non-continuous in nature.

Figure 11.7 shows a simple bar chart. It is usual to have the variable or attribute on the horizontal axis and the frequency on the vertical axis. When percentages are used, the sum of the heights of all the bars should be equal to 100%. Occasionally, a bar chart is drawn in which the frequency is represented on the horizontal axis, as shown in Figure 11.8.

When two or more distributions involving descriptive variables need to be compared, a multiple bar chart gives a visual comparison of the two. Figure 11.9 compares the distribution of registered health workers in government and private practice. Each group of workers is represented by a pair of bars, one showing workers in government service and the other those in private practice.

Figure 11.7. Bar chart showing distribution of married couples practising contraception by the main method used

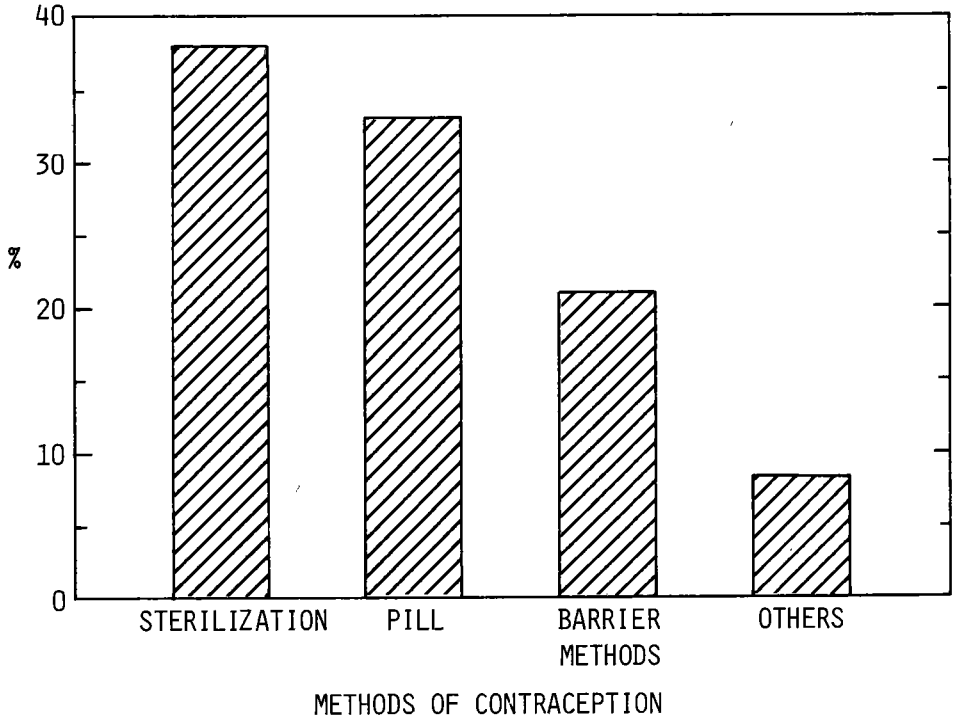


Figure 11.8. Bar chart showing the main source of information on health matters, as reported by individuals in a household survey

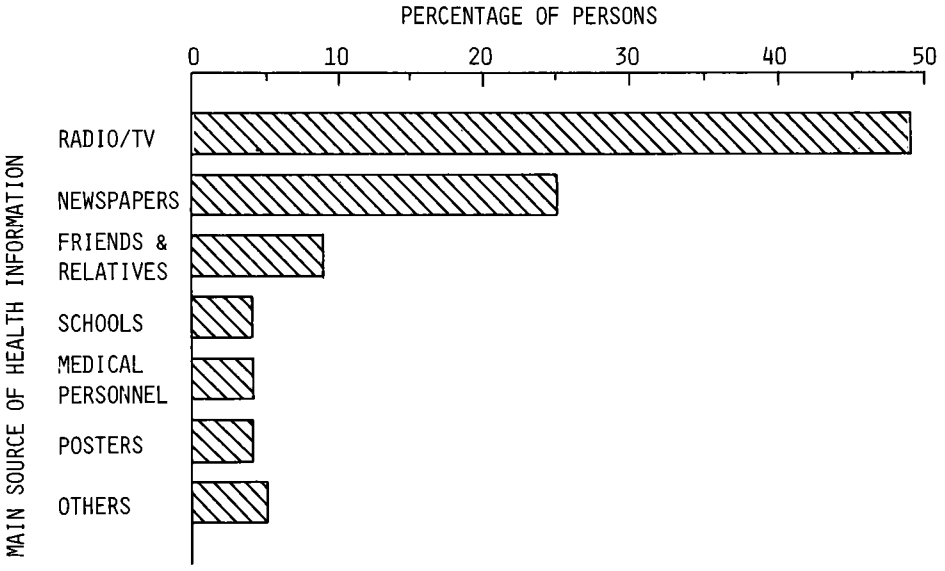
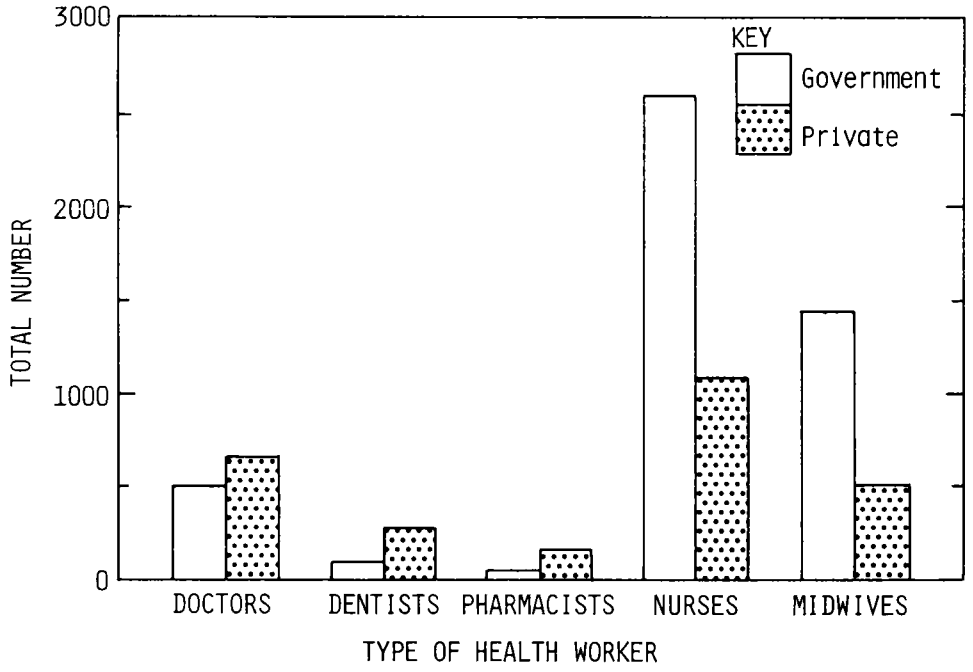


Figure 11.9. Multiple bar chart showing numbers of registered health workers in government employment and in private practice in December 1987



11.5 Pie charts

Figures 11.10 and 11.11 show typical pie charts. These are circular diagrams cut up into several segments or pieces, representing the frequency distribution of the various groups or divisions of a descriptive variable. Pie charts often use percentage distributions, so that a hemisphere represents 50% (half of the pie) and a quadrant 25% and so on. To draw a pie diagram requires the use of a compass, and a protractor for marking out the segments.

The pie chart can also be used for comparing two or more distributions (see Figure 4.2). Pie charts are useful for explaining information clearly to people who are not used to handling numbers.

Figure 11.10. Percentage of the district health budget spent on primary health care facilities during one year

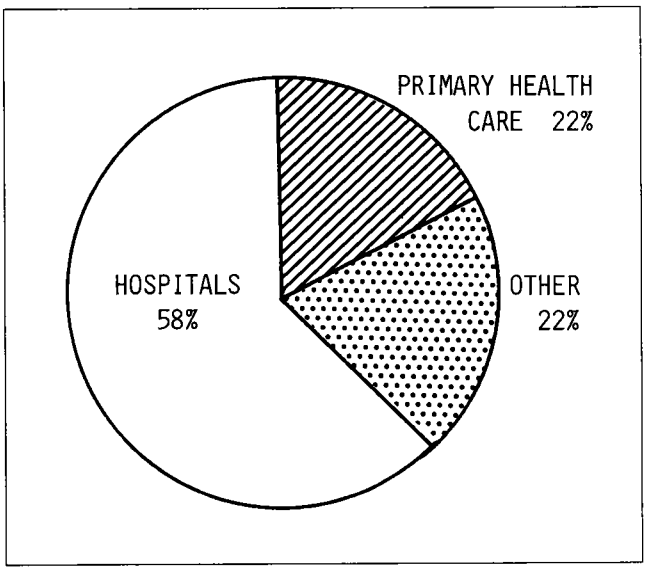
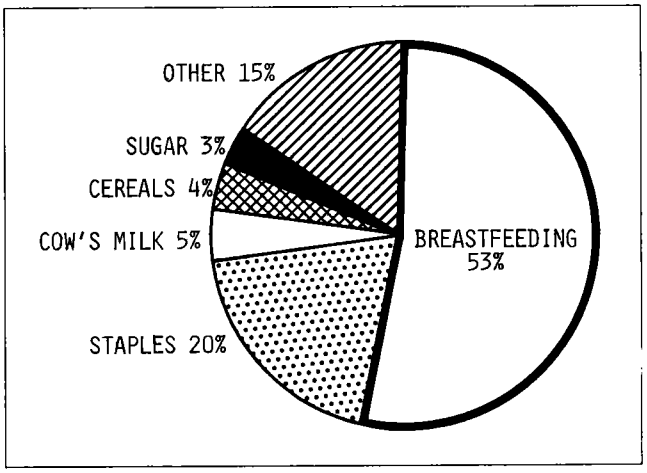


Figure 11.11. Main source of calories for infants aged 6 to 12 months



11.6 Scatter diagrams

These are very useful for displaying information on two connected variables that show a **bivariate distribution**. For example, when information is obtained on both the baby's birth weight and gestational age, the two distributions are said to be bivariate.

A scatter diagram is formed when the bivariate distributions are plotted, with birth weight on the vertical axis and gestational age on the horizontal axis (Figure 11.12). The name comes from the scatter or spread of the individuals in the sample with respect to the two variables. In drawing the scatter diagram, each dot on the diagram represents the pair of measurements made on one baby. Thus the point marked with a circle in Figure 11.12 represents an infant whose gestational age was 35 weeks and whose birth weight was 3 kg.

Scatter diagrams are used because they show visually whether an **association** or **correlation** exists between the two variables. The example in Figure 11.12 shows that there is a positive association between birth weight and gestational age. An infant with a high gestational age tends to be heavier at birth than an infant with a low gestational age. The scatter diagram can only suggest such an association: statistical techniques are necessary to measure and test the actual strength of this correlation (see Section 10.7).

Figure 11.12. Scatter diagram showing the distribution of 50 live newborn infants delivered in a hospital by birth weight and gestational age

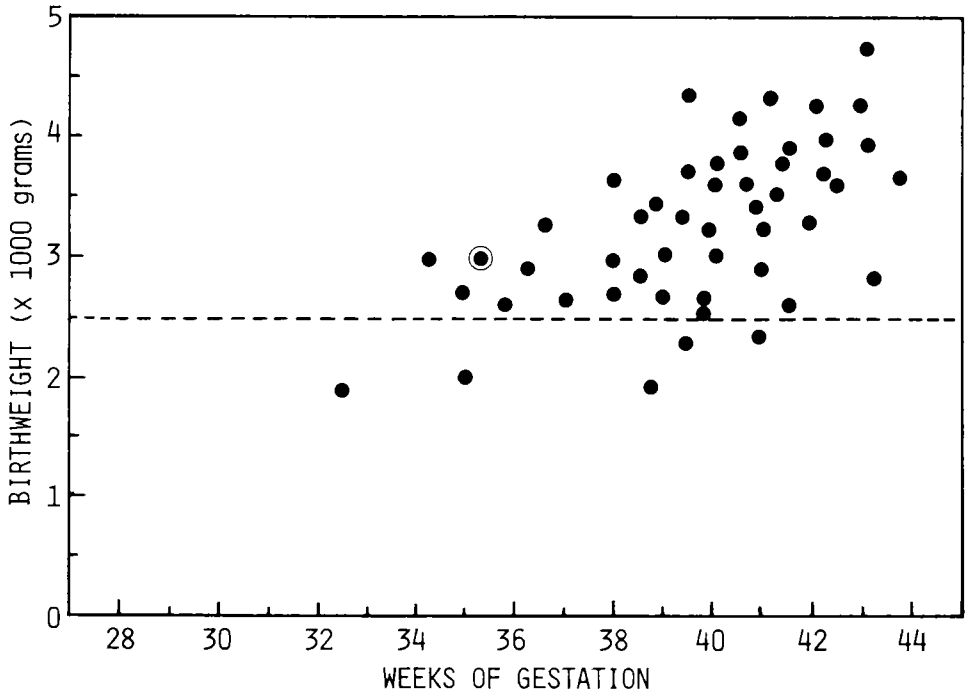


Figure 11.12 also shows that 5 infants had a birth weight below 2500 g, that is, they were low-birth-weight babies. In this sample, therefore, the **low-birth-weight rate** is 5 out of 50, or 10%.

11.7 Maps

Maps of a district are extremely valuable, particularly for showing a **geographical distribution** (see Figures 11.13 and 13.3). They can show, for example, the local distribution of particular diseases (e.g. leprosy, schistosomiasis) or health programme activities (e.g. clinic sites, protected water sources). Maps can show clearly the geographical distribution of cases in an epidemic and the pattern of spread can suggest which disease is causing the epidemic (see Figure 6.4). Maps published by central government may show which diseases occur in the district or demonstrate comparisons between districts for such items as infant mortality rates or immunization coverage.

Figure 11.13. Local map showing the transmission sites of Onchocerca volvulus and Schistosoma mansoni close to villages A, B, C and D

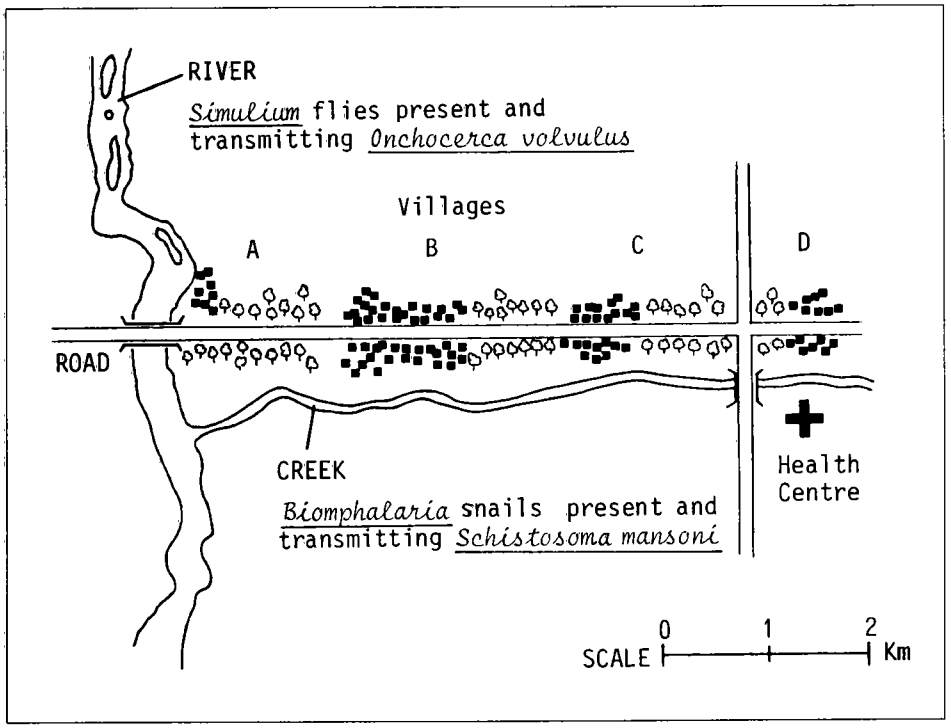


Figure 11.13 demonstrates the value of local maps. During an analysis of the health centre records it was found that most cases of onchocerciasis came from village A and some from B, whereas most of the cases of *Schistosoma mansoni* infection lived in villages C and D, with some others coming from village B. An investigation showed that *Simulium* flies (the vector of onchocerciasis) were breeding in the main river, whereas the *Biomphalaria* snails (an intermediate host for schistosomiasis) were living in the creek. Once a detailed local knowledge of disease transmission has been obtained, control measures can be implemented at the appropriate sites.

CHAPTER 12
Communicating Health Information

12.1 Importance of communications

Too often information on district health matters, whether it comes from the routine system or from special investigations, remains poorly used and unpublished. The findings and conclusions are not put into a written report and are rarely communicated to other people. Just as serious is the fact that the information is often not used by the district management team itself. Thus, sadly, the full potential of this newly collected information is frequently unexploited. Good information, besides being useful, can also be very influential and persuasive. If DHMTs recognized this and communicated their findings and recommendations more effectively, district health plans could get much greater support from the community and nongovernmental organizations, as well as from district-level government and the ministry of health. In this way DHMTs would be better advocates for health.

GOOD INFORMATION CAN BE VERY INFLUENTIAL

Information can be communicated in three main ways:

- By writing and disseminating full reports.
- Through meetings and discussions with local organizations.
- Through local and mass media.

A report should communicate the findings and recommendations to the:

- District authorities.
- District health workers.
- Local community organizations.
- Nongovernmental health organizations.

- Regional health authorities.
- Ministry of health.

Figure 12.1. Discussing health information with community leaders

A written report is fundamental to communicating health information obtained from analysis of the district health data or from an investigation or survey, and a good report carries a great deal of influence and status.

12.2 Health reports

The style and content of the written reports will depend on their nature and purpose and on who is likely to read them.

The following points should always be considered when writing a report:

- The report should be clearly written using simple language with short sentences and paragraphs.
- The title should clearly explain what the report is about.
- If possible, the main part of the report should not be longer than 10 pages and include only the most relevant points.

- The draft report should be discussed with colleagues and community leaders before the final report is written.
- A number of drafts may have to be written before the final version.

A report usually contains the following **sections**, each of which should be clearly labelled. Depending on the circumstances, sections may be subdivided or combined and items may be moved to more appropriate sections if indicated.

Title page. This should show the full title of the report, the names of the authors and their positions and addresses.

The title must be clear, e.g. "Malaria in Amber District: the prevalence of *Plasmodium falciparum* infection in ten villages in July 1986."

Summary. This is best placed immediately after the title page. It should be limited to the main findings and recommendations and in order to catch the eye of the reader it should be less than two pages long.

Introduction and purpose. This section should set out the background information and purpose of the study or investigation, together with the reasons for it. Any relevant literature or previous work can be summarized here.

Objectives must be clearly stated. For example:

- To measure the prevalence of *Plasmodium falciparum* infection in ten villages in Amber district during 1986.
- To identify high-risk groups for malaria infection with regard to age, sex, place of residence, and use of mosquito nets and repellents.

Methods. The study population should be described first and then the sampling method, stating the sampling frame, procedure and sample size. If controls are used, the method of selection should be explained.

The response rate – the percentage of the original sample eventually seen – should be given, together with the possible reasons for non-response. The representativeness of the sample and its comparability to the whole district population should be briefly discussed.

All the variables should be described. This applies not only to the disease or event being measured, but also to other variables such as age, sex, ethnic group and occupation.

The operational definition of the variables should be given next, such as the criteria used to diagnose the diseases, assess age, or to

place a person into a particular occupational group. The procedures to elicit these criteria need to be described, for example, the method of palpating for the spleen in the diagnosis of malaria or of relating a person's birth to a well-known event to estimate age. All this is important for the reader to judge the suitability of the methods and the comparability of the findings to other studies.

The method of information collection should then be described. If a questionnaire was used, the type (open or closed) should be mentioned. If possible, a sample of the record form and questionnaire should be given in an appendix to the report. The interviewers and the training given to them to minimize observer variation should be described. If observer variation was measured, the results can be given.

The pilot survey carried out to refine the methods should be described and the consequent amendments mentioned.

Results. All the relevant findings should be explained in the text. Clear and brief tables should be used to present the important data and figures should illustrate particularly important findings.

Tables and figures should be self-explanatory, with clear titles, legends and footnotes, and each one should show only the one or two most important points. For the tables, check that the totals (especially percentages) add up correctly. Numbers normally need be given to an accuracy of one decimal place only. When there is more than one line in a graph, each one should be clearly labelled and differentiated.

Discussion and interpretation. This is where the results are interpreted and the conclusions made clear. Comparisons can be made with other relevant studies. The limitations of the study (and there are invariably some) should be indicated. It is in this section that the authors can give their own opinions and suggest explanations. They may also give their reasons why any controversial decisions were made.

Recommendations. All recommendations should be listed and numbered. These will probably include:

- Action to be taken to control a disease or improve a preventive health programme.
- Other recommendations for future action, which can be divided according to the levels at which they are directed, such as:

  community organizations;

  district authorities;

  regional governments;

  ministry of health.

WHAT ACTION HAS BEEN TAKEN ON THE RECOMMENDATIONS?

References, acknowledgements and appendices. These last pages make up the final details of the report. Any material that you feel should be communicated, but which is not essential in the main part of the report, can be placed in an appendix. It is most important to acknowledge all the people who helped and supported the work described in the report. To do so is a strength, not a weakness.

12.3 Suggested length of reports

Obviously the actual length of a report will depend on the scope of the work, but as a guide the following is suggested. Since reports nearly always come out longer than originally intended, start by aiming for a maximum of 10 pages.

	Number of pages
Title page	1
Summary	1
Introduction	2 – 4
Methods	2 – 4
Results	3 – 6
Discussion	2 – 4
Recommendations	1 – 2
Main body of report (excluding title page and summary)	**10 – 20**

CHAPTER 13
Epidemiology and District Health Planning

13.1 Primary health care and district planning

The **epidemiological responsibilities** of the DHMT were outlined in Chapter 1 where they were divided into those concerned with health information and those concerned with health planning, management and evaluation. This chapter is concerned with the use of epidemiology to support these latter functions.

Health planning, management and evaluation for primary health care are complicated matters, and their organization will vary considerably from country to country. This chapter can only present an outline for the use of epidemiology for these activities, as the details will depend on how districts are organized in each individual country.

In health planning there are three important questions:

- Where do we want to be in future? – **"there"**
- Where are we now? – **"here"**
- How do we get from **"here" to "there?"**

The first question—**Where do we want to be?**—requires the development of **national health policies and plans**, stated in operational terms, based on clear goals, and specific objectives and targets.

To answer the second question—**Where are we now?**—involves assessing the health status of the population, determining the available resources in terms of health facilities, staff, equipment and finances, and finally evaluating the access, coverage, efficiency and effectiveness of the health facilities and their health programmes. It is most important that community perspectives are also taken into account in answering this question.

The third question—**How do we get from "here" to "there"?**—involves determining the priorities to be tackled, the health activities that have to be organized and the management support that is needed.

In district planning and management, information is needed to answer these three questions, but the available information is never as complete or as accurate as would be desirable. In many cases the DHMT will have to make decisions on the basis of estimates – sometimes frank guesses – and it will probably have to set aside resources to improve the information for next year. However, whatever the quantity and quality of health information currently available, the DHMT will need to set objectives for programmes for the coming year.

District planning for primary health care needs to take into account at least the eight main elements of PHC shown below. Some countries have expanded this list, while others have decided to give greater priority to some elements than to others. However, all the elements are important for PHC and the aim should be to make them all available to the whole district population.

Which of the following elements are being implemented by the district?

- Education on prevailing health problems and methods of preventing and controlling them.
- Provision of food supplies and promotion of proper nutrition.
- Adequate supply of safe water and provision of basic sanitation.
- Maternal and child health care, including family planning.
- Immunization against the major infectious diseases.
- Prevention and control of locally endemic and epidemic diseases.
- Appropriate treatment of common diseases and injuries.
- Provision of essential drugs and supplies.

The degree to which **strategies** for the implementation of PHC in districts are realized frequently depends on national and local health plans.

The following are commonly adopted strategies:

- Training and use of community members as health workers.
- Community participation in planning and implementing health programmes.
- Intersectoral coordination, particularly between agriculture, education, housing, sanitation and water supplies.
- Collaboration between health organizations, particularly governmental and nongovernmental agencies and traditional and private practitioners.
- Decentralization by the ministry of health and the strengthening of the district health system.

13.2 Health plans

Broad **health policies** and long-term **development goals** are generally the responsibility of the national government. Most countries have accepted PHC as the means of achieving their health goals and have developed **national health plans** that take into account their own particular health problems and the resources available for achieving health for all.

For example, the ministry of health may state its long-term goals as follows:

- To maximize the total amount of healthy life for the people.
- To ensure that all nationals have ready access to primary health care.

In order to quantify these goals, the following **targets** might be set for the whole country to achieve by the end of the next national health plan:

- The infant mortality rate should be reduced from the present national average of 110 to 80 per 1000 live births per year.
- Health facilities should be developed so that 80% of the population live within 10 km of a facility.
- Supervised deliveries should be increased from the current national average of 40% to at least 65%.

A target is a specific objective which is quantified and which is to be achieved over a specified period of time. It is a common practice to use such targets to indicate what needs to be achieved in the next

year or over the next five years. With clearly stated goals and quantified and time-limited targets, the ministry of health can produce **medium-term** or **five-year health plans** for the whole country, incorporating plans to strengthen the infrastructure of health services and health personnel development, as well as to improve promotive, preventive and curative health programmes. It is essential that targets are formulated as realistically as possible, taking into account the projected financial resources and available staff. The ministry of health will need a substantial input from the districts to develop realistic medium-term plans.

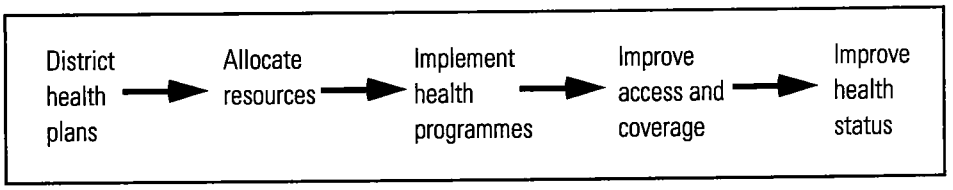
The medium-term plans must in turn be translated into a series of **annual plans**, which are used to calculate the budget requests for the recurrent and capital expenditures for the following financial year. The DHMT frequently has responsibility for these planning and budgeting processes.

DOES THE DISTRICT HAVE ANNUAL AND MEDIUM-TERM HEALTH PLANS?

Some countries do not use plans covering fixed time periods, but rely on a system of **rolling plans**. These commonly cover a period of between three and five years ahead, the details being worked out only for the next one or two years. At the end of each one or two years the plans are rolled forward to cover the next year or years ahead. In this kind of planning system, annual or biennial plans are the most important.

Health plans are only the starting point for improving district health management. This process can be presented in a simplified form, as shown in Figure 13.1 below, but it is best understood as a continuing cycle.

Figure 13.1. Outline of district health management



The district health plans should contain an analysis of the present situation and the health priorities that need to be tackled. On the basis of this knowledge the DHMT, local government, community organizations and nongovernmental agencies can then allocate the money, manpower and facilities needed to implement the necessary health programmes. These programmes should aim to improve access to health care and the coverage achieved, which in turn should lead to improvements in health status.

Epidemiological skills are thus crucial for members of the DHMT. These skills are needed to obtain and interpret the health information necessary for producing the district plans and for guiding the

allocation of resources, for monitoring the implementation of programmes and for assessing their access and coverage, and finally for measuring changes in health status.

13.3 Present health situation

The starting point for district planning, for both annual and medium-term plans, is a detailed analysis of the **present situation** in the district in order to produce the **district health profile**, which helps to answer the planning question, **Where are we now?** This profile allows today's situation to be seen as a starting point for planning improvements. However, the DHMT needs to be realistic about where it is now and how much it can achieve over the next few years.

To produce a useful district health profile requires a combination of a good local knowledge of the district and all the available health information. The DHMT needs such details as those given in Chapter 3 on the district population and in Chapter 4 on health status. To these must be added information on the district health services and health programmes, covering the eight essential elements of PHC. A list of useful indicators has been presented in Chapter 2 and a checklist for producing a **district health profile** is given at the end of this chapter (see Section 13.11).

Health indicators are essential for analysing the present situation in the district, for expressing specific targets and for assessing whether these targets are being met or not. Keeping the district health profile up to date should preferably be a continuous activity, or at least an annual one. The information should be analysed, displayed and widely communicated – as suggested in Chapters 10, 11 and 12. Visual displays showing progress in the indicators should be given wide publicity.

The indicators shown in the profile are the basic ones that can be quantified and should be available. In addition, there is a great deal of other information about the district, such as its history, geography, socioeconomic conditions and political system, that the DHMT will also need to know in order to make realistic health plans.

The district health profile lists important indicators under the following categories:

- District population.
- Health status.
- Health resources.
- Health programmes.

ANALYSE THE PRESENT SITUATION USING THE HEALTH INDICATORS IN THE DISTRICT HEALTH PROFILE

The indicators for the district population were covered in Chapter 3. The **health status indicators** cover nutritional status, morbidity and mortality. The **health resources indicators** are for facilities, staff and finances. The **health programme indicators** cover pregnancy and delivery, child care, environmental health and clinical care. A similar listing of basic indicators will probably be accepted by most ministries of health, but every DHMT will need to work out the details of any additional indicators it wishes to use.

13.4 Developing district priorities

The next step in district health planning is to answer the question: **How do we get from "here" to "there"?** An analysis of the present situation, as shown by the district health profile, should provide a basis for this.

The analysis should identify the following:

- Main health problems.
- High-risk groups.
- Access to and coverage by health programmes.
- Organization and management of these programmes.

Districts will always have insufficient health resources; so it is important that the DHMT decides on the **priorities** for developing PHC in the district. Choices must be made: which population groups, diseases or underlying health problems should be given priority? Which health programmes should receive more attention and more resources? Good epidemiological health information is necessary to help answer these questions.

PLANNING INVOLVES DECIDING ON PRIORITIES

Making these choices is a difficult process; full consideration must be given both to the priorities in the national health plan of the ministry of health and to local priorities decided on by the district itself. Political, social and economic factors, as well as the present health status, must enter into the decision-making. Although the overall mix of health services provided in the district will be determined at the national level, each district will have its own special problems. Many important decisions on priorities must be made at the district level, by the DHMT, and involving community representatives, local councils and the planning offices of the local government.

Health plans must take into account the need for a balance between the following components:

- Promotive and preventive health care, such as community programmes for health education, mother and child health care, immunization, nutrition and environmental health.

- Preventive disease control, with specific programmes for communicable diseases such as tuberculosis, malaria, cholera, rheumatic heart disease and for selected noncommunicable diseases such as hypertension and accidents.
- Curative services for ill people, based on primary health care and care at the first referral level and/or district hospital.
- Reasonable access to these services by the district population, through community health posts, health centres and other outreach services.
- Development and upgrading of health workers through training and retraining programmes.
- Adequate transport, communications and supplies for all these activities.

There is no single "right" way to decide which health interventions or programmes should receive priority, but some "rules of thumb" have proved helpful. Priorities should be developed in terms of the activities that will have the greatest impact on improving the health status of the district. The DHMT will need to develop programmes for carrying out these activities effectively and efficiently. A **priority chart** is a useful method for organizing health information for use in deciding on priorities. Each disease is given a simple score for its relative importance (based on its frequency, morbidity and mortality); for the effectiveness of the possible interventions; and for the costs of these interventions. The total score for the three aspects provides an approximate guide to the priority of each intervention. Each of the three aspects is given an appropriate score as follows:

	Score		
	+	++	+++
Relative importance of disease	low	moderate	high
Effectiveness of interventions	ineffective	moderate	very effective
Cost of interventions	high	moderate	low

Examples are shown in Table 13.1.

It is assumed that priority should be given to diseases or underlying health problems that are frequent, severe and cause high morbidity and/or high mortality, and against which there are effective and cheap interventions. Epidemiological knowledge and experience are essential for making use of such a priority chart. Assigning scores is a matter for consultation and discussion among members of the DHMT and other health staff, and between community representatives, local government officers and staff in other government sectors. For convenience this chart has been organized for diseases, but planning decisions must also be made on how to improve the appropriate interventions and health programmes. Some programmes,

such as those for immunization or the provision of water supplies, cover several different diseases and for these programmes the appropriate disease scores can be added together to arrive at a priority for each programme or set of activities.

A major advantage of such a scoring system is that it uses all the epidemiological information collected in the district and focuses the discussion on each major health problem in turn. Some communicable diseases, such as African trypanosomiasis and dengue, may have a low frequency but they can cause severe epidemics and hence long-term control programmes may be given a high priority.

Table 13.1. Chart for determining health priorities, with examples

Disease	*Relative importance (based on frequency, morbidity and mortality)*	*Effectiveness*	*Costs*	*Priority score*
Measles	+++	+++	+++	9
Diarrhoeas	+++	++	+++	8
Malaria	+++	++	++	7
Tuberculosis	++	++	++	6
Cerebral vascular accidents	+++	+	+	5
Leukaemia	+	+	+	3

13.5 High-risk groups

In working out priorities for annual and medium-term plans another method is to consider which groups of people should receive priority in the district. Every man, woman and child is at risk of getting ill and dying, but some groups are at a much higher risk. These are called **high-risk groups**. Not only are some people at high risk for some diseases but they may also make less use of the available health services – that is, they are also at high risk of not getting the necessary health care. Epidemiological information is essential for defining these high-risk groups, which can be recognized by common features of Who? Where? and When? Health plans can give priority by selecting certain high-risk groups and thus concentrating on the development of PHC for these groups.

High-risk groups include:

- Women aged 15-44 years, who comprise about one-fifth of the total population.

- Infants and young children, also about one-fifth of the total population. A high proportion of all deaths from malnutrition and communicable diseases, such as measles, diarrhoeas, pneumonias and malaria occur in this group.
- Some workers, particularly those working with machinery and using dangerous chemicals, as well as labourers and construction workers.
- Old people, who suffer from chronic diseases.
- Contacts of people with infectious diseases, such as tuberculosis and leprosy.
- Certain cultural and socioeconomic groups, such as poor families, people of low caste, subsistence farmers and recent migrants.
- Certain ethnic groups or subgroups that are predisposed to high risk by their beliefs and customs.

WHO ARE THE PEOPLE AT HIGH RISK?

- People living far away from health facilities, who are at high risk of not getting a service they require.
- People living in areas affected by seasonal and climatic changes, such as areas where the incidence of malaria increases considerably in the rainy season .

13.6 Improving the provision of health care

There is no standard way to measure and compare the provision of health care, but two important concepts are those of **access** and **coverage**. Access measures the proportion of the district's population that has a particular facility within reasonable reach, which may be measured by distance (e.g. 5 or 10 km), time (e.g. 1 or 2 hours' travelling), costs (e.g. travel fares and health service fees), and social and cultural factors (e.g. caste or language barriers). Access to a health service within a reasonable distance must be a high priority for all district health planning for PHC.

Coverage is a measure of the percentage of people or households in need of a health service or facility who actually receive it, for example the percentage of households with a safe water supply or the percentage of pregnant mothers who have attended for antenatal care.

Epidemiological information is necessary to find out both the denominator, such as total number of households or pregnant women in the district, and the numerator, such as the number of houses with a water supply or the number of pregnant women who have attended an antenatal clinic at least once. The expanded programme on immunization (EPI) commonly measures coverage by using the percentage of young children who have been immunized, with, say, three doses of DPT (diphtheria-pertussis-tetanus) vaccine.

IMPROVING ACCESS AND COVERAGE IS A HIGH PRIORITY

It is clear that coverage can only be high if access is high. For example, EPI coverage will remain low if a high proportion of people do not have reasonable access to a health centre or subcentre offering immunizations. In this situation a district might have to use mobile clinics and mass vaccination campaigns in order to achieve a satisfactory coverage.

Information for calculating the denominators is usually derived from information on the district population, as described in Chapter 3. Information for calculating the numerators comes from figures provided by official government publications and, in the district, from the routine information system, surveillance, and from special investigations and surveys.

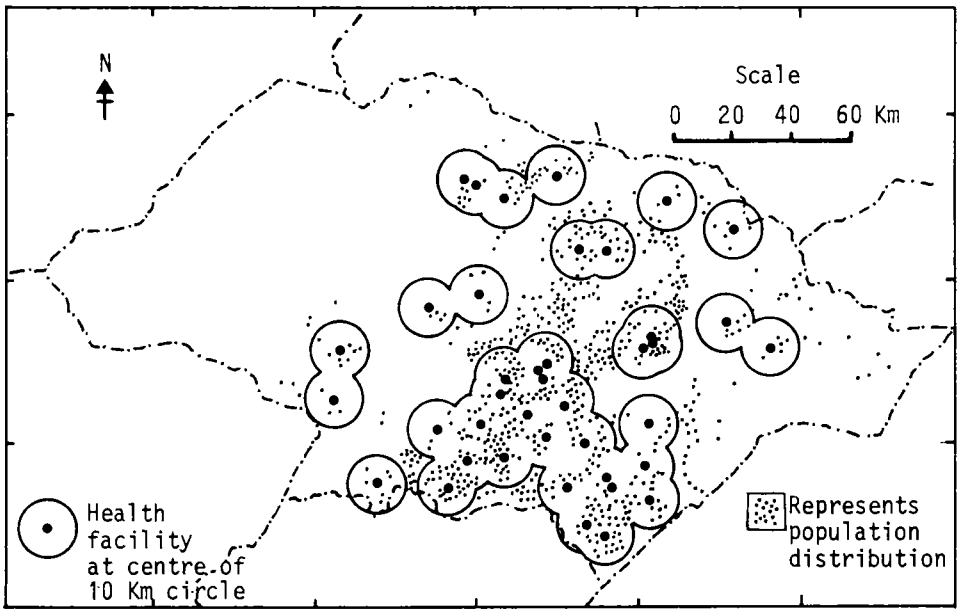
Figure 13.2. It takes about one hour to walk 5 km

13.7 Estimating access

A major priority must be for a high proportion of people to have reasonable access to a community health worker, a health post or a health centre, say within 5 or 10 km of their home, which is the equivalent of 1 to 2 hours' walking. In rural areas distance is commonly used to reflect access, because of poor communications and transport. In urban areas and where transport is available, it is frequently more important to define access in terms of time, costs or social factors.

A useful method for estimating geographical access is to draw 5- or 10- km circles around each health facility on a district map and then to calculate the percentage of the total district population who live within those circles. This is illustrated in Figure 13.3. In this example, it was found that 75% of the district population lived within 10 km of a health facility and 50% were within 5 km.

Figure 13.3. District map showing population distribution and those living within 10 km of a health facility



13.8 Estimating coverage

To estimate coverage, it is most important that members of the DHMT learn to use and interpret the health indicators that may already be available for the district. The most important step is to have reliable information on the **expected number of people, events or attendances** in the district and then to calculate the actual coverage the district is achieving. The district coverage can then be

compared with the national situation. Rates derived from special censuses and surveys are likely to be more reliable than those based on the routine health information reported by health facilities or on surveys carried out on a small sample.

The accuracy of routine data is sufficient for most planning, management and evaluation purposes at district level. Sometimes, however, special surveys are justified if some important information is missing.

Example: In a district with 200 000 people, about 4% are less than one year old (as given by the national census), which gives a total of about 8000 infants. The district routine health information system reported that 2400 children under one year of age received 3 doses of DPT vaccine during the year.

$$\text{Coverage for 3 doses DPT} = \frac{2400}{8000} \times 100 = 30\%$$

If the national coverage is known to be 45%, and the long-term objective is to reach 80%, the DHMT will need to ask itself some serious questions, first about access to health care and secondly on the management of the district immunization programme.

The achievement of a **high coverage for the main services and programmes** is the single most important managerial objective for the DHMT. For example, the following coverage indicators are given in part 4 of the district health profile in Section 13.11:

- Percentage of all births attended by a trained health worker.
- Percentage of 1-4-year-old children weighed regularly.
- Percentage of all cases of pulmonary tuberculosis who are receiving treatment.
- Percentage of households with an adequate water supply.
- Percentage of married couples who are currently using a modern method of family planning.

By estimating coverage, the DHMT is **analysing the present situation** and obtaining a measure of how well it is meeting the operational targets that were established the previous year. The next step is to fix a target for the improvement to be achieved during the following year. However, if the DHMT decides that the district coverage of a particular service is reasonable, the objective may be to maintain the same level of coverage for next year. Annual plans may then give higher priority to achieving improvements in other services.

13.9 Developing the district health plan

If the DHMT has used the available epidemiological information and followed the above steps in health planning, it should by now have completed the following planning processes:

- Analysed the present situation, including health status, in the district.
- Developed the priorities for the next annual and medium-term plans.
- Decided on which high-risk groups should receive priority.
- Made plans to improve access and coverage for the priority health programmes.
- Decided on the objectives and indicators to evaluate progress.

Once the district health problems have been identified, the main priorities established and the objectives and indicators chosen, the next step is to develop the framework for the medium-term plan. Only then should the more detailed annual plans be drawn up. The annual plans are the means of achieving the medium-term objectives.

Once the processes have been completed, the DHMT should be in a good position to plan all the **health programme activities** that are needed to make the health plans work.

DECIDE ON PRIORITIES, SET OBJECTIVES, SELECT INDICATORS AND PLAN ACTIVITIES

It is important to stress that health planning is a complicated and dynamic process. What is outlined here is a logical sequence, but planning does not take place in a purely logical way. The DHMT is advised to select a few important problems and not to attempt to be comprehensive. If all the problems are taken together they will present an impossible task and district health planning may not even be attempted.

The best approach, therefore, is to tackle only one or two priority problems at a time. The following is a useful sequence for developing a plan of action, but for more guidance the DHMT will need to consult their national health plan and the Ministry of Health's guidelines for district planning.

- **Choose a strategy.** There may be several different ways to achieve the objectives. For instance, plans to reduce maternal mortality might include increasing the proportion of supervised deliveries at health centres, training traditional birth attendants, improving antenatal attendance rates and identifying high-risk mothers. As planning proceeds, the practical constraints become clearer and the DHMT may find that it has to revise its original strategy.

- **Undertake consultations on the proposed strategy.** The community representatives and organizations, nongovernmental health organizations, other sectors and local governments will all need to comment and collaborate if PHC is to be successful. Local political parties and politicians can give powerful support.
- **Identify all the necessary activities.** Sort out all the activities and tasks and determine the implications for staffing, facilities, supplies, transport and budgets. Consider also the implications for community participation, intersectoral coordination and the collaboration of all the other health care providers.
- **Establish a timetable.** Estimate the time required for all the activities and then fix starting and completion dates. These should be realistic and, if possible, contained in the annual plan.
- **Assign responsibility to staff.** The DHMT will need to identify individuals and organizations that will be responsible for carrying out the different activities needed to make the strategy work.
- **Allocate funds.** Funds are always limited, so the DHMT needs to estimate costs very carefully. Recurrent and capital costs are usually estimated separately.
- **Monitor and evaluate progress.** It is not sufficient just to plan, it is also necessary to find out whether the plan works. Can the routine system give the necessary health information? Is epidemiological surveillance or a special survey required?
- **Display and communicate the plan.** It is most important that everyone involved understands the health plan, including all the activities and time schedules, and knows the names of the responsible staff. Maps, charts and graphs can be very useful for this display. Opportunities should be taken to communicate the plans at meetings. Local government should also be kept well informed. The district health profile (see Section 13.11) is the most important means of demonstrating progress.

13.10 Evaluating progress

Implementation of the district plan for primary health care can be evaluated in two main ways. The first is to assess what **programme activities** have been achieved compared to what the DHMT proposed in the district plan. The second is to see if the indicators of health status have improved or if the frequency of disease or underlying health problems has been reduced. Well planned activities have to be implemented over several years to achieve an improvement in overall health status indicators or a reduction in the frequency of many diseases or underlying health problems. The indicators contained in the district health profile are helpful for charting progress.

CHART PROGRESS USING HEALTH INDICATORS

The DHMT should be able to evaluate its progress in implementing health programme activities, but it is usually a much more difficult problem to assess changes in health status. Although epidemiological health information must be used in evaluation, it is also important for the DHMT to combine this with its own knowledge and experience. It is this combination of information with experience that will enable the DHMT to make judgements and draw conclusions as to how well PHC is being implemented in the district.

The main steps in undertaking an evaluation as part of district health management are:

- Select the necessary indicators for the health activities.
- State the objectives to be achieved in terms of the indicators.
- Collect the necessary epidemiological health information.

HAVE THE OBJECTIVES BEEN ACHIEVED?

- Compare the results achieved with the targets.
- Judge the extent to which the targets have been met.
- Review the strategy and district health plans and make new annual plans for next year.

Where a series of activities has to be performed over the twelve months, a useful technique for **monitoring progress** is to use a cumulative graph. The total activity to be performed in one year is divided by 12 to give the target for each month. Plotting the target values and the cumulative graph by monthly totals shows the progress being made each month.

Example: In a district with 200 000 people there are 4.0% under one year old, which makes a total of 8000 infants. The DHMT wants to improve on last year's average EPI coverage of 30% to meet the national figure of 45% coverage with three doses of DPT vaccine. Thus, the total number of infants to be fully immunized by the end of the year is:

$$\text{No. of infants to be immunized per year} = 8000 \times \frac{45}{100} = 3600$$

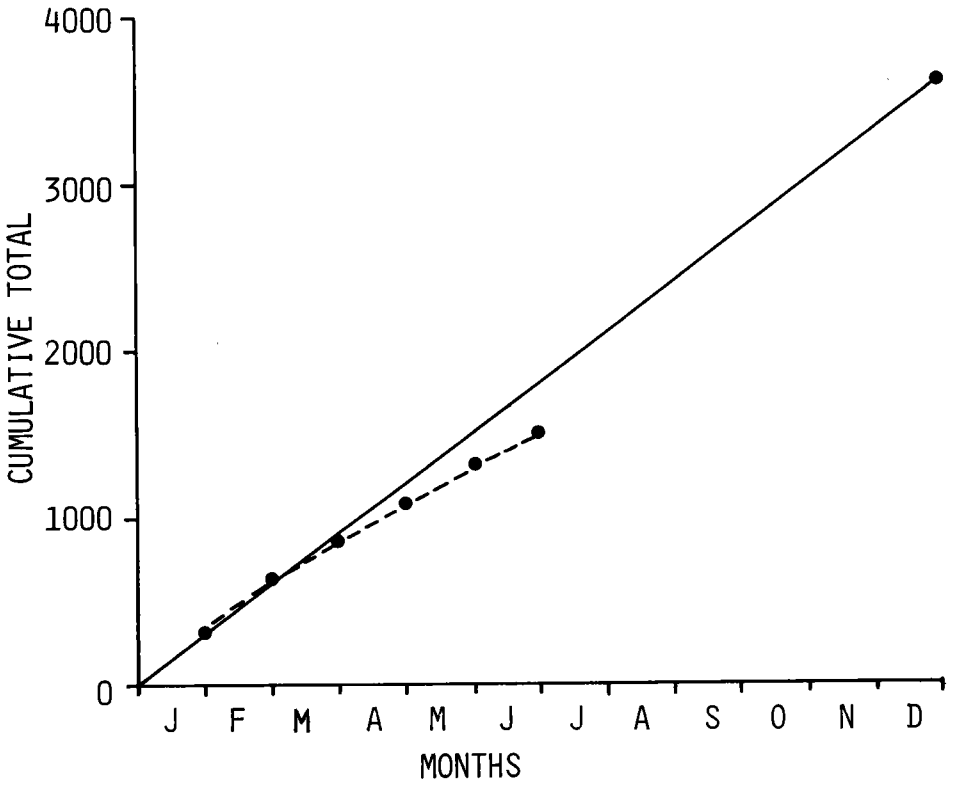
$$\text{No. of infants to be immunized per month} = 3600 \times \frac{1}{12} = 300$$

The actual numbers of infants fully immunized with 3 doses of DPT are as follows: January 310, February 300, March 280, April 240, May 200, and June 170. Thus, the cumulative totals are as follows:

	Monthly total	*Cumulative total*
January	310	310
February	300	610
March	280	890
April	240	1130
May	200	1330
June	170	1500

The cumulative graph is shown in Figure 13.4. The average for January to June was 250 infants immunized per month. The immunization started off well but then started to fall short of the objective of 300 infants per month. This suggests that the DHMT will have to review the programme activities to find out why the programme is not working well. The alternatives are to put in more effort and to attempt to achieve a new monthly total of 350 per month for the rest of the year, or to decide that the annual objective is too ambitious and that it is only realistic to immunize 250 infants per month, which is equal to 3000 per year or an estimated coverage of about 38%. This would be an improvement on the previous year but still falls short of the national average.

Figure 13.4. Cumulative graph showing number of infants fully immunized by month compared to the objective of an average of 300 per month over one year



13.11 Summary of district health profile

This section presents a list of indicators for use in compiling information for a district health profile to be used in health planning, management and evaluation. The indicators have been arranged as follows:

District Population
- Total
- By age group
- Births
- Fertility

Health Status
- Nutrition
- Morbidity
- Mortality

Health Resources
- Facilities
- Personnel
- Finances

Health Programmes
- Pregnancy and delivery
- Child care
- Environmental health
- Clinical care

This profile should be adapted to local circumstances. The list contains only selected indicators and is not meant to be fully comprehensive. It also needs to be emphasized that not all the possible health programmes have been included and only four are given as examples. The years 1 to 5 are shown to draw attention to the importance of annual and medium-term plans, for which targets can be set and for which health information can be kept and updated as time passes.

District Health Status and Health Planning Profile

	Year 1	Year 2	Year 3	Year 4	Year 5
1. DISTRICT POPULATION					
A. Total estimated					
B. Total by age group					
0–11 months					
1– 4 years					
5–14 years					
15–45 years					
45+					
C. Total births estimated					
Crude birth rate					
General fertility rate					
D. Rate of growth					

	Year 1	Year 2	Year 3	Year 4	Year 5
2. HEALTH STATUS					
A. Nutritional status					
Infants					
% with low birth weight					
Children					
Weight for age					
No. between 3rd and 50th centile					
%					
No. below 3rd centile					
%					
No. not making progress (Less than 50%)					
%					
1-4 year olds					
Upper-arm measurement 12.5-14 cm					
No.					
%					
Upper arm circumference less than 12.5 cm					
No.					
%					
B. Morbidity					
Selected specific diseases by number of new cases diagnosed					
Diarrhoea					
Jaundice					
Malaria					
Measles					
Neonatal tetanus					
Typhoid					
Whooping cough					
Diseases requiring prolonged therapy					
Tuberculosis					
No. of new cases expected					
No. of new cases diagnosed					
No. of cases completing therapy					
No. of cases defaulting					
No. of cases currently under therapy					

	Year 1	Year 2	Year 3	Year 4	Year 5
Leprosy					
No. of new cases expected					
No. of new cases diagnosed					
No. of cases completing therapy					
No. of cases defaulting					
No. of cases currently under therapy					
Epidemic diseases					
Meningococcal meningitis					
Cholera					
Dengue					
Trypanosomiasis					
Yellow fever					
C. Mortality					
Total deaths					
Total deaths estimated for district					
Crude estimated mortality rate					
Expectation of life					
No. of deaths registered					
Estimated percentage registered					
No. of deaths certified					
Estimated percentage certified					
Estimated age-specific death rates					
Infants					
1– 4 years					
5–14 years					
15–44 years					
45+ years					
Maternal mortality					
No. of deaths registered					
No. of deaths expected					
Disease-specific mortality					
diarrhoea					
malaria					
malnutrition					
measles					

	Year 1	Year 2	Year 3	Year 4	Year 5
pneumonia:					
0-4 years					
5+ years					
tuberculosis					
3. HEALTH RESOURCES					
A. Facilities					
Health stations, posts, etc.					
No. needed for district					
No. operating					
% of those needed					
% of population with access					
Hospitals					
Total no. of hospital beds in district					
Population to bed ratio					
B. Personnel					
Primary health care					
Workers needed					
Workers in post					
No. of TBAs in district					
No. of TBAs trained					
% trained					
Hospital care					
No. of professional nurses needed					
No. of nurses in post					
%					
No. of practical nurses needed					
No. of practical nurses in post					
%					
No. of doctors needed					
No. of doctors in post					
%					
No. of laboratory and technical personnel needed					
No. in post					
%					

	Year 1	Year 2	Year 3	Year 4	Year 5
C. Finances					
Total health system expenditure in district					
Per capita expenditures					
Expenditure on primary care					
Expenditure on hospital care					
4. HEALTH PROGRAMMES					
A. Management of pregnancy					
Total no. of expected deliveries in district					
No. of pregnant women who received prenatal care					
% receiving prenatal care					
No. of deliveries attended by trained TBAs or health personnel					
No. of deliveries in health centres or hospitals					
% attended by trained personnel					
Estimated no. of couples using birth spacing/family planning (FP) services					
No. of couples accepting birth spacing services for first time					
No. of women aged 15-45					
% of couples continuing FP (compared to all women aged 15-45)					
B. Child care					
Infants					
Immunization					
No. of infants born in the year					
No. receiving DPT vaccine					
% receiving 1 dose					
2 doses					
3 doses					
No. receiving polio vaccine					
% receiving 1 dose					
2 doses					
3 doses					
No. receiving measles vaccines					
%					
No. receiving BCG vaccine					
%					

	Year 1	Year 2	Year 3	Year 4	Year 5
Antimalarials					
No. of infants receiving antimalarials regularly					
% of infants receiving antimalarials					
Nutritional assessment					
No. of infants weighed at least once during year					
% weighed at least once					
No. of infants weighed at least six times					
% weighed six times					
1-4 year olds					
Antimalarials					
No. of 1-4 year olds					
No. receiving antimalarials					
% receiving antimalarials					
Nutritional assessment					
No. of 1-4 year olds assessed regularly					
% assessed regularly					
C. Environmental health					
Water supply					
Total no. of communities or households					
No. with adequate water supply					
% with adequate water supply					
Excreta disposal					
No. with adequate control					
% with adequate control					
Refuse disposal					
No. with adequate disposal					
% with adequate disposal					

	Year 1	Year 2	Year 3	Year 4	Year 5
D. Clinical care					
Clinic visits					
No. of visits to village-level clinic					
Population per clinic					
Subcentre visits No./yr					
No. referred from village					
% of visits referred from village					
Population in subcentre area					
Health centre visits No./yr					
No. referred from subcentre					
% referred from village and subcentre					
Total no. of outpatient clinic visits					
No. of clinic visits per person per year					
Hospital admissions					
No. of hospital (non-maternity) inpatients					
No. of hospital days					
No. of hospital admissions for preventable causes					
No. of admissions					
Infants					
1– 4 years					
5–14 years					
15–44 years					
45+ years					
No. of deaths in hospital					
Infants					
1– 4 years					
5–14 years					
15–44 years					
45+ years					
No. of maternity admissions					
No. referred because of risk factors					
No. with unexpected complications					
No. of maternal deaths in hospital					

CHAPTER 14
A B C of Definitions and Terms

The definitions given in this chapter are valid as they are used in this publication but different definitions may be used in other contexts. This chapter is largely based on *A dictionary of epidemiology*, edited by J.M. Last for the International Epidemiological Association and published by Oxford University Press, 1983.

A

Access. The proportion of a defined population that has a particular facility within reasonable reach, which may be measured by distance, time, costs or social and cultural factors.

Accuracy. The degree to which a measured value represents the true value of the variable that is being measured. *See* Repeatability and Validity.

Agent. A factor whose presence or deficiency is essential for the occurrence of a disease, e.g. microorganisms, chemical substances, vitamins and essential amino acids.

Age-sex pyramid. *See* Population pyramid.

Age-specific rate. A rate for a specified age group, with the numerator and denominator for the same age group.

$$\text{e.g. 1-4 year mortality} = \frac{\text{Number of deaths among 1-4 year old children in area in one year}}{\text{Average total population aged 1-4 years in same area in same year}} \times 1000$$

Airborne infection. A disease caused by an infectious agent capable of being transmitted by particles or droplets suspended in the air, e.g. measles and pertussis.

Arbovirus. A group of diverse animal viruses that are transmitted to humans by blood-feeding arthropod vectors, such as mosquitos, ticks, sandflies and midges. The term is an abbreviation of "arthropod-borne virus".

Association. Statistical dependence between two or more variables, which are said to be associated if they occur together more frequently than would be expected by chance. Statistical tests enable the degree of association to be calculated.

Attack rate. This rate usually refers to the incidence of new cases during an epidemic. The secondary attack rate is based on the number of new cases among contacts of a primary case that occur within the accepted incubation period of the disease. The denominator is the total number of exposed contacts during the same period of time.

Average. *See* Mean, arithmetic

B

Bias. Any effect during the collection or interpretation of information that leads to a systematic error in one direction, e.g. errors resulting from weighing scales under-recording a child's true weight, or observer bias in the interpretation of replies to questions in a questionnaire.

Birth rate. A summary crude rate based on the number of live births in a known population over a given period of time.

$$\text{Birth rate} = \frac{\text{Number of births in area during one year}}{\text{Average total population in area during the same year}} \times 1000$$

Birth weight. Infant's weight recorded at the time of birth. Low-birth-weight babies weigh less than 2500 grams and the percentage of such babies is commonly used as a general measure of health status.

C

Carrier. A person or animal that has a specific infectious agent in the absence of clinical disease and that serves as a potential source for the further transmission of the infection.

Case. A person who is identified as having a particular characteristic such as a disease, behaviour or condition. An epidemiological definition of a case is not necessarily the same as the clinical definition. Cases may be divided into possible, probable and definite, depending on how well specific criteria are satisfied.

Case-control study. An analytical epidemiological study that compares cases of a particular condition with suitable control subjects, who do not have the condition, looking at the frequency of associated factors in the two groups. Sometimes also called a retrospective study. Often used to test hypotheses about etiology, e.g. the link between lung cancer and cigarette smoking.

Case-fatality rate. The percentage of persons contracting a disease who die from it. This rate is most commonly used for communicable diseases.

$$\text{Case-fatality rate} = \frac{\text{Number of deaths from a disease in a given period}}{\text{Number of cases of disease diagnosed in the same period of time}} \times 100\ \%$$

Catchment area. The geographical area from which the people attending a particular health facility come.

Census. The enumeration of an entire population, usually with details being recorded on residence, age, sex, occupation, ethnic group, marital status, birth history and relationship to head of household. A *de facto* census only counts the people who are actually present during the enumeration, whereas a *de jure* census records all people by their normal place of residence at the time of enumeration.

Chemoprophylaxis. The administration of drugs to prevent infection from occurring or to prevent the infection from progressing into disease.

Class. A group of observations made on a variable, considered together for the convenience of analysis, e.g. haemoglobin values may be classed by intervals of 1g/dl.

Clustering. The grouping of a series of cases in relation to time or spacial area or both. The space-time clustering of cases in an epidemic commonly indicates a point-source outbreak due to an infectious agent or toxic chemical.

Cluster sampling. A sampling method in which each unit selected is composed of a group of persons rather than an individual, e.g. villages and households.

Cohort. A well defined group of people who have had a common experience or exposure, who are then followed up for the incidence of new diseases or events, as in a cohort or prospective study. A group of people born during a particular period or year is called a birth cohort.

Communicable period. The time during which an infectious agent may be transferred from an infected person to another susceptible person, or from an animal to man or vice versa.

Confounding. A situation in which the effects of two variables are difficult to separate from each other, e.g. level of family income and availability of food as causes of malnutrition.

Contact. Exposure to a source of an infection. Transmission due to direct contact may occur when skin or mucous membranes touch, as in body contact, kissing and sexual intercourse.

Contagious. Transmitted by contact or close proximity.

Control. Disease control programmes aim to lower the incidence of new cases, or reduce the proportion of severe cases through treat-

ment, to an acceptably low level, so that the disease is no longer considered a major public health hazard.

Control group. Comparison group of people who do not have a particular disease or condition or who have not been exposed to the disease, intervention, procedure or other variable that is being studied. Neighbourhood controls, which are commonly used for convenience, are people who live in the same neighbourhood. *See also* Case-control study.

Correlation. A measure of association that indicates the degree to which two or more sets of observations fit a linear or straight-line relationship. Correlation may be positive, when both variables increase together, or negative, when one increases as the other decreases.

Coverage. A measure, usually expressed as a percentage, of people or households who have actually received a particular service compared to all those who need it, e.g. percentage of households with a reasonably safe water supply, percentage of infants immunized with three doses of DPT vaccine.

$$\text{e.g. obstetric coverage} = \frac{\text{Number of deliveries attended by a qualified health worker}}{\text{Total expected number of deliveries in the same population during the same period of time}} \times 100\ \%$$

Cross-sectional survey. A survey or study that examines people in a defined population at one point in time. Cross-sectional surveys usually supply prevalence data but repeated surveys can be used to give an estimate of incidence.

D

Data processing. Conversion of raw data into a form suitable for analysis with computers and statistical programmes.

Death rate. The proportion of a population who die from any cause during a specified period of time. The rate can be made specific for a particular cause, or group of causes, of death. The rate can also be calculated for each sex and for any age group, thus providing disease-, sex- and age-specific rates.

$$\text{Crude death rate} = \frac{\text{Number of all deaths during one year}}{\text{Average total population during same year}} \times 1000$$

Demand for health care. Willingness and/or ability to seek and use services. Sometimes further divided into expressed demand or actual use and potential demand or need.

Demography. The study of populations, with reference to such factors as size, age structure, density, fertility, mortality, growth and social and economic variables.

Denominator. The lower portion of a fraction. In the calculation of a rate, this represents the total population at risk.

Disease, subclinical. The condition in which a disease is only detectable by special tests and there are no apparent symptoms and signs.

E

Endemic. The constant presence of a disease or infectious agent in a given population or geographical area. Also used to refer to a disease with a constant incidence of new cases in the area.

Epidemic. The occurrence in a community or region of cases of an illness or other similar event clearly in excess of what is normally expected. The characteristics of the illness, the area and the season all have to be taken into account. To judge whether there is an excess or not requires knowledge about the previous incidence of the event in the same area.

Epidemiology. The study of the distribution and determinants of health and disease in populations and its application to the prevention and control of health problems and diseases.

Eradication. The extermination of an infectious agent, thus halting transmission of infection e.g. smallpox has been eradicated throughout the world and malaria has been eradicated from certain areas.

Evaluation. A process that attempts to determine as systematically and objectively as possible the relevance, effectiveness and impact of activities in the light of their objectives. Evaluation is often carried out separately for inputs, processes, outcomes and impact.

Expectation of life. The average number of years an individual is expected to live if current mortality trends continue. Life expectancy at birth is the average number of years a newborn baby can be expected to live under existing conditions. As many deaths in developing countries occur during infancy and childhood, the average life expectancy in these countries is much lower than in developed countries.

F

False negative. A false result in a screening test, leading to the classification of a person, who is actually positive, as negative or normal.

False positive. A positive test result in a subject who is actually negative, i.e. a healthy person is wrongly said to have a particular disease or attribute.

Fertility rate. *See* General fertility rate.

Fetal death rate. Also called stillbirth rate. The number of fetal deaths in one year expressed as a proportion of all births (live plus stillbirths) in the same year.

$$\text{Fetal death rate} = \frac{\text{No. of fetal deaths in one year}}{\text{No. of fetal deaths plus live births in same year}} \times 1000$$

G

General fertility rate. Similar to the crude birth rate, except that the denominator is restricted to women of childbearing age, i.e. 15-44 years.

$$\text{General fertility rate} = \frac{\text{No. of live births in area in one year}}{\text{Average female population aged 15-44 years for same area and year}} \times 1000$$

Growth rate of populations. Also known as the natural rate of population increase. In the absence of the effects of migration, it is calculated as the crude birth rate minus the crude death rate.

H

Health. A state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity.

Health indicator. A measure that reflects, or indicates, the state of health of persons in a defined population, e.g. the infant mortality rate.

Health information system. A combination of health statistics from various sources, used to derive information about health status, health care, provision and use of services, and impact on health.

Herd immunity. The resistance of a group or community to invasion and spread of an infectious agent, due to the resistance to infection in a high proportion of individual members of the group. The herd immunity results from the lowered probability of the disease agent being transmitted from an infected person to a susceptible one when a high proportion of individuals are not susceptible.

Holoendemic. Describes a disease that is virtually universal in the population, with symptoms in childhood, leading to a state of equilibrium and a lower incidence of symptoms in adults, e.g. malaria in some communities, especially in Africa.

Host. A person or animal that is infected under natural conditions. A number of microorganisms and parasites may have several different hosts.

Household interview survey. The collection of information from a representative sample of households by trained interviewers. It is usually a cross-sectional survey to collect information about individual members and on common features, e.g. water supply.

Hyperendemic. A disease that is constantly present at a high incidence (or prevalence) and that affects all age groups.

I

Incidence. The number of new cases or events or attendances occurring in a defined population within a given period of time, commonly one year.

Incidence rate. A measure of the rate at which new cases or events occur in a defined community.

$$\text{Incidence rate} = \frac{\text{No. of new cases or events diagnosed in population in one year}}{\text{Average total population at risk in same area in one year}} \times 1000$$

Incubation period. The time interval between invasion of a susceptible host by an infectious agent and the appearance of the first symptom or sign of the disease.

Infant mortality rate. A measure of the rate at which deaths occur in children less than one year old.

$$\text{Infant mortality rate} = \frac{\text{No. of deaths in children less than 1 year old in one year}}{\text{No. of live births in same year}} \times 1000$$

M

Maternal mortality rate. A measure of a woman's risk of dying from causes associated with pregnancy. A maternal death is the death of a woman while pregnant or within 42 days of the termination of pregnancy, irrespective of the duration and the site of pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes. Some countries have extended the period of 42 days to up to one year.

Maternal deaths are subdivided into (a) direct obstetric deaths and (b) indirect obstetric deaths resulting from pre-existing disease or disease that developed during pregnancy and which was not due to direct obstetric causes, but which was aggravated by

physiological effects of pregnancy. The death of a pregnant woman from an incidental cause (e.g. motor car accident) is not classified as a maternal death.

$$\text{Maternal mortality rate} = \frac{\text{No. of maternal deaths in given area during one year}}{\text{No. of live births in the population in the same area during the same year}} \times 10\,000$$

Mean, arithmetic. This is also commonly called the average. It is calculated by adding together all the individual values in a group of measurements and dividing by the number of values in the group.

Measurement scale. The complete range of possible values for a measurement. Scales can be divided into five main types:

dichotomous - two mutually exclusive groups, such as positive and negative.

nominal – qualitative categories, such as for religions.

ordinal – ordered qualitative categories, such as social classes I to V.

interval – scale with equal distances for each interval but no particular starting or zero point, such as date of birth.

ratio – interval scale with a zero starting point, such as weight, blood pressure, income.

Median. The central value in a range of measurements that divides the set into two equal parts.

Mode. The most frequently occurring value in a set of observations.

Monitoring. The continuous measurement and observation of the performance of a service or programme to see that it is proceeding according to the proposed plans and objectives. If monitoring reveals that there are problems, management decisions will have to be taken to alter or improve the service or programme so that it comes back on track.

Morbidity. Any departure from a state of wellbeing. Morbidity can be expressed in terms of people who are ill and/or as episodes of illness.

N

Neonatal mortality rate. The number of deaths in infants under 28 days of age in a given period, usually one year, per 1000 live births in the same period.

Non-respondents. Members of a study sample or population who do not take part, respond or participate, for whatever reason, in the study. Respondents may differ from non-respondents and a high non-response rate may be an important source of bias.

Notifiable disease. A disease that, by statutory requirements, must be reported to the public health authority.

Numerator. The upper portion of a fraction. In calculating a rate, all people included in the numerator should have been derived from the denominator. However, this is not true for the numerator in a ratio.

O

Observational study. Study, survey or investigation that is made by observing subjects and where no interventions, or at least no additional ones, are implemented at the same time.

Observer error. Variation or error in measurements due to failure of the observer to measure or identify the phenomenon accurately. Variation can be due to such faults as the observer missing an observation, poor technique, incorrect reading or recording, and misinterpretation of answers to questions. Observer error is particularly important if it is non-random and biased.

Output. The immediate results that come from health care or programme activities expressed as units of service, such as number of outpatient visits or persons immunized.

P

***P* or probability value.** The letter *P* followed by <, the symbol for less than, and a number (usually 0.05, 0.01 or 0.001) is a statement of the probability that the association or observation could have occurred by chance. The number 0.05 means the observation would be expected to occur by chance 1 in 20 times; similarly, 0.01 means 1 in 100. An association is commonly accepted as statistically significant if *P* is <0.05.

Pandemic. An epidemic occurring over a very wide area.

Pathogenesis. The mechanism by which an etiological agent produces disease.

Perinatal mortality rate. The officially accepted definition is as follows:

$$\text{Perinatal mortality rate} = \frac{\text{Late fetal deaths (28 weeks or more gestation) plus first-week postnatal deaths}}{\text{Fetal deaths plus total live births in same population over same period}} \times 1000$$

However, the definition accepted in many countries that do not have good vital statistical records leaves fetal deaths out of the denominator. Perinatal mortality is a useful indicator of the quality of antenatal and obstetric care and is usually given as a rate per 1000 births per year.

Population. The total number of inhabitants of a given area or country. In sampling, the population may refer to the units from which the sample is drawn, not necessarily the total population of people. The term population is also commonly used to refer to particular subgroups, such as priority or high-risk groups.

Population pyramid. A graphical representation of the age and sex composition of a population. A pyramid with a broad base, sloping sides and narrow apex is typical of many developing countries. This shape is due to high fertility and high mortality at younger ages.

Postneonatal mortality rate. The number of infant deaths between 28 days and one year of age in a given year per 1000 live births in that year. In developing countries this rate largely reflects deaths due to infectious diseases and malnutrition.

Predictive value. The probability that a person with a positive (or negative) result in a screening or diagnostic test is in fact a true positive (or true negative) . These are called the positive and negative predictive values of the test. The predictive value depends on the sensitivity and specificity of the test and on the prevalence of the condition being screened. *See* Validity.

Prevalence. The number of cases or events or conditions in a given population at a particular point in time.

Prevalence rate. The total number of cases or events or conditions at a particular point in time divided by the total population at risk at the same point in time. Prevalence rates are most commonly used for diseases or events that have a long average duration.

Prevalence study or survey. *See* Cross-sectional study.

Prevention. Measures aimed at promoting and maintaining health, by such interventions as improving nutritional status, immunization, suitable water supplies and excreta disposal (primary prevention). Secondary prevention comprises measures aimed at ensuring the early detection of diseases and infections, whereas tertiary prevention is concerned with reducing symptomatic illness and disability.

R

Random. Describes a happening or event due to chance and not determined by other factors.

Randomization. The separation or allocation of individuals to two or more groups at random. Randomization should form two or more groups with variables randomly allocated between the groups.

Randomized controlled trial. An experiment using people randomly allocated to treatment or intervention groups and a control group. The results are assessed by looking for any significant difference between these groups. Such trials are the most rigorous and scientific way of testing the effectiveness of new interventions.

Random sample. A sample derived by random selection of sample units. Each individual unit, such as village, household or person, should have an equal chance of being included in the sample.

Relative risk. The ratio of the risk of death or disease in an exposed population to the risk in the unexposed population.

Repeatability. The ability of a test to produce results that are identical or closely similar each time it is conducted. Precision is another term that is often used. *See* Accuracy and Validity.

Representative sample. A sample that resembles the original population or reference population in every way. To ensure this, all chosen samples should be compared with the original population, particularly for important variables such as age and sex.

Reservoir of infection. The natural habitat of an infectious agent, which may be a person, animal, arthropod, plant, soil, etc. It is where the agent normally lives and multiplies.

Response rate. The number of interviews or examinations completed divided by the total due to have been carried out, expressed as a percentage. A high non-response rate can be an important source of bias.

Retrospective study. *See* Case-control study.

Risk. The probability that an event will occur, e.g. that an individual will become ill or die within a stated period of time or age. The term is usually used with reference to unfavourable events.

Risk factor. The term is used in at least two different ways: (1) an attribute, variable or exposure that is associated with an increased probability of a specified event, such as the occurrence of a disease. Such preceding factors are not necessarily causal (also called risk markers); (2) an attribute, variable or exposure that actually increases the occurrence of a specified event, and is therefore believed to be causal (also described as a determinant).

S

Sample. A selected subset of a population. A sample may be random or non-random and it may be representative or non-representative. In an *epsem* (equal probability of selection method) sample all the population units have an equal chance of being selected. A simple random sample is an *epsem* sample.

Screening. This is the presumptive identification of unrecognized disease or behaviour by using tests, examinations, questionnaires and other procedures. Screening sorts people into positives and negatives or normals. People who are positive will probably require further investigation. It is important to examine the results for the proportion of false positives and false negatives. *See also* Sensitivity and Specificity.

Sensitivity. The proportion of true positives correctly identified by a screening test. *See* Predictive value and Specificity.

Seroepidemiology. The use of serological investigations, particularly antibody levels, to detect infections and transmission patterns.

Socioeconomic status. A descriptive classification of a person's position in society, using such criteria as income, educational level, occupation and dwelling place. Attitudes towards health and health status are often closely linked to socioeconomic status.

A classification similar to the one used by the Registrar-General of the United Kingdom is as follows:

Social group	*Occupation*
I	professional
II	intermediate
III N	non-manual skilled
III M	manual skilled
IV	partly skilled
V	unskilled

This classification may be applicable in an industrialized society but is less useful in many developing countries.

Specificity. The proportion of true negatives correctly identified by a screening test. *See also* Predictive value and Sensitivity.

Sporadic. A disease or event that occurs infrequently and irregularly. A term usually applied to certain communicable diseases.

Spot map. A map showing the geographical distribution of people with a particular characteristic, commonly used in the investigation and control of an epidemic.

Standard deviation. A measure of the dispersion or variation of a set of quantitative observations or measurements on either side of the mean or average.

Standardization. Application of statistical techniques to standardize two or more populations for differences that may exist between them, particularly in the age-sex structure, to enable valid comparisons to be made.

Statistical significance. See *P* or probability value.

Stillbirth rate. *See* Fetal death rate.

T

Total fertility rate. An estimate of the total number of children a thousand women would bear if they went on having children at the present age-specific fertility rates. It provides an answer to the question: How many children does a woman have on average during her lifetime?

Transmission of infection. The spread of an infectious agent, either through the environment or from person to person. The main mechanisms of transmission are: direct contact, placental, fomite-borne, vector-borne and air-borne.

Trend. A long-term general movement or change in frequency, usually either upwards or downwards. A downward trend in a disease or unhealthy behaviour means that it is becoming less frequent.

U

Under-reporting. Failure to identify or count all cases or events, leading to a numerator that is smaller than the true one. This leads to estimates of frequency that are lower than the true value.

V

Validity. The degree to which a measurement actually measures or detects what it is supposed to measure. This concept is particularly important in screening procedures. *See* Accuracy and Repeatability.

Variable. Any characteristic or attribute that can be measured.

Virulence. The degree of pathogenicity, or ability to produce disease, of an infectious agent.

Vital statistics. Systematically tabulated information about births, marriages, divorces and deaths, based on registration of these vital events.

Z

Zoonosis. An infectious or communicable disease that can be transmitted from vertebrate animals to human beings.

APPENDIX 1 Ethical guidelines for epidemiological investigations

These guidelines were developed by the Scientific Working Group on Epidemiology of the UNDP/World Bank/WHO Special Programme on Research and Training in Tropical Diseases, World Health Organization, Geneva.

Background

These guidelines focus specifically upon ethical aspects that have posed particular problems in epidemiological studies of communities in developing countries. They are intended as a supplement to the Declaration of Helsinki[a] and the WHO/CIOMS guidelines on research involving human subjects,[b] and should not be viewed in isolation. They represent provisional guidelines for consideration, not rules for execution.

The international declaration concerning ethics as set forth in the Declaration of Helsinki, adopted by the 18th World Medical Assembly in 1964 and revised by the 29th World Medical Assembly in 1975, covers well most of the important ethical considerations concerned with clinical research in human subjects. The WHO/CIOMS proposed international guidelines for biomedical research involving human subjects were framed with special reference to developing countries and focus on problems of informed consent from certain disadvantaged subjects, such as children, the mentally ill or prisoners, and broadly ethical problems of developing countries and community-based research. Further, the guidelines discuss ethical review procedures at institutional and national levels and touch upon the need to inform communities in which research will be undertaken and upon the need for compensation from accidental personal injury.

The ethical concerns of controlled clinical trials, which are well outlined in these documents, include some that are also important to epidemiological studies. In particular the ethical issues surrounding three matters—informed consent, use of control or comparison (e.g. placebo) procedures, and trials of drugs or other materials that have not been approved for use in humans in the country of origin—all may be of great importance in epidemiological studies in developing countries, but are not specifically reviewed here.

---

[a] *WHO Chronicle*, **30**: 360-362 (1976).

[b] *Proposed international guidelines for biomedical research involving human subjects*. Geneva, CIOMS, 1982.

Level of review

Proposals for research activities should undergo several levels of procedural review, as described below.

Individual

The fundamental level of review is the individual person; every participant in a study must provide informed consent to take part in the research. The many complex issues that informed consent may involve are generally well covered in the above-mentioned documents. Illiteracy and differing cultural concepts of health and disease do not alter the basic principles of informed consent. Written consent may be a legal requirement in some countries, but from the ethical viewpoint it is neither necessary nor sufficient. Written consent *per se* is not the requirement; the critical need is that the person consenting has an understanding of the procedures, including the benefits and hazards. Informed consent should not be considered as an inhibiting factor in research: indeed, a properly informed subject may be a much more useful participant.

Community

The second level of review, which may be of particular importance for some types of epidemiological research, is a review by the community. It is not simply a matter of consent; it is a matter of understanding. For a research programme involving a community, the community and the researchers should be working in partnership since the purpose of the research should be mutually rewarding. A well informed community will not only be more cooperative, but also more useful in its collaboration.

National level

The third level is that of the responsible institutional or national review body and is well covered in the WHO/CIOMS guidelines.

International

The final level of review for externally sponsored projects (i.e., those funded by an external national or international agency) should ensure that the research protocol conforms to the requirements of the Declaration of Helsinki and that the approaches to the three prior levels are documented.

Detailed procedures for obtaining individual consent or community understanding will vary considerably and must be left to the responsible institution and/or national review bodies and to the principal investigator.

Obtaining approval at all levels and, in particular, obtaining the informed consent of individuals in no way reduces the responsibility of the investigator to these individuals and their communities. A checklist of suggested areas for review at each level is given at the end of this appendix.

Issues of particular concern to epidemiological studies in developing countries

Health care expectations of the community

Epidemiological studies made in a community or other defined population in developing countries may involve important considerations that are not encountered in clinical research. In many areas, the only medical care available to the population is that of traditional practitioners, and modern health care with the infrastructure required for its delivery may be minimal or absent. The conduct of a health-related research programme brings with it the quite reasonable expectations on the part of the people that some kind of health care will be provided. One-shot, "bleed and fly" safari-type studies have often produced unfulfilled expectations in the people, leading to disappointment and reduced cooperation for future studies. Although one-shot studies have had their usefulness – and may not raise ethical issues when directed at solving a specific health problem such as an epidemic – they are generally unacceptable today. Such studies, usually carried out by outsiders, in addition to raising expectations among the people, make no long-term contribution to the health infrastructure or the research capabilities of the country. Almost always the same information can be better obtained through direct cooperation with institutions in the host country.

Longitudinal community-based studies inevitably raise the expectations of the people for improved health care. There are no clear answers to the vexing questions raised by these expectations. The first step is that a reasonably full understanding must be achieved between the community and the researchers before, during and after the research. Frequently, during a longitudinal, community-based study, the health infrastructure must be strengthened in order to obtain information about the health of the people. When this is the case, every attempt should be made to strengthen it on a continuing basis by such means as training, improved record-keeping, development of sampling procedures for future use. In general, it is understood that the actual provision of health care is the responsibility of the national health services and community: therefore, the researcher must work closely with both and resolve these issues as fully as possible.

Involvement of local personnel

Related to this is the need to strengthen the research infrastructure on a continuing basis whenever possible. At the least, this means as much involvement as possible of local personnel in the early stages of design of the protocol, its implementation, the collection of data, and the analysis and feedback of the information to the community and the government.

Control or placebo groups

In establishing the effectiveness of virtually any intervention procedure (vaccine trial, mass drug distribution, etc.) on a community basis, the need for control or placebo groups may create special problems. The basic ethical issues are the same as those in clinical trials, but the procedures used may be different. Important principles are (1) that the control group receive the best currently established form of intervention, if one exists, and (2) that if the new intervention procedure is demonstrated to be better (e.g. higher benefit/cost ratio) then it should be provided to the control population as soon as possible.

All the people concerned should be fully informed about the proposed research. They should be provided with a clear explanation of the investigation, the reasons for undertaking it and the possible implications. Any coercion is unacceptable.

Sometimes there may be practical problems in determining who truly represents the community; occasionally it is necessary to work through dual channels where there may be both legal and traditional authorities. Generally full discussions with community leaders – before, during and after the completion of the research – are both necessary and very helpful. Again to be emphasized is that the ultimate objective of research is to improve the health of those in the community; hence a cooperative partnership arrangement to ensure full understanding on the part of both the researchers and the community is vital.

Use of past medical records

Epidemiological studies carried out from a hospital or clinical base rarely raise ethical issues that are different from those of any other clinical research investigation. Although there has been some concern in the United Kingdom and the USA concerning the use of past medical records without specific individual consent of both the doctor and the patient as a potential "invasion of privacy", it is no longer considered an issue provided that there is no identification of individual patients and that complete confidentiality is assured. As long as these principles are adhered to, the issue seems unlikely to become a problem in developing countries.

Anonymity of the community

The anonymity of the community, in general, should be protected with the same degree of concern as that given to the protection of the individual. If, as often happens, sensitive data emerge in the course of the studies of a community, it will be the responsibility of the investigator to use the utmost discretion in relating these data. However, sometimes the location and the circumstances are important to an understanding of the research that has taken place. Very often no purpose is served in not revealing the identity of the community. Indeed sometimes a community may take pride in being

associated with the research. The best approach is to have continuing communication with the community as suggested above in the community review procedures (level 2 review).

Behavioural research

It has sometimes been forgotten that informed consent may apply to observation of personal behaviour just as with any other research method affecting human subjects. The use of hidden observers and secret observation procedures (including photography) is rarely justifiable in behavioural research. When observers are required, as in research into human contact with water, their existence should be made known, but they can, of course, be stationed inconspicuously without being hidden. Experience has shown that such observers are eventually accepted—and even ignored.

Environmental effect

In wide-scale application of measures to control vectors or intermediate hosts of disease organisms, the effect on the community and the environment of the methods used must be anticipated and carefully monitored.

Ethics in training

Training at all levels should include consideration of the ethical issues that will be involved in the trainees' future duties.

Checklist

The following is a checklist of suggested areas for review at each level:

- **Parent institution; funding organization**
  - scientific merit of the study
  - consistency with ethical guidelines
  - monitoring of results
  - implementation of recommendations.
- **National review committee**
  - scientific merit of the study
  - consistency with ethical guideline
  - use of controls
  - confidentiality of records
  - anonymity of subjects
  - use of non-intervening observers
  - cost to the community under study
  - means of communication to the community of the nature of the research

- nature of informed consent
- acceptance of the research by the study community
- potential conflict and competition between proposals
- termination of controlled trials
- end points in the research process
- implementation of recommendations
- communication of results to the community.

- **Local community**
  - nature and necessity for research
  - possible harm and possible benefits to the community
  - communication of issues to the people
  - obtaining of consensus and the non-desirability of coercion
  - monitoring of results
  - implementation of recommendations
  - end points.
- **Individual**
  - informed consent is required from all individuals.

Acknowledgements

These guidelines were originally drafted by Professor H. M. Gilles, Dean, Liverpool School of Hygiene and Tropical Medicine, with assistance from Professor F. Dunn, University of California, Berkeley. A number of useful suggestions from members of the Scientific Working Group on Epidemiology and the secretariat of the UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases have been incorporated into the present version. Special thanks are due to Professor I. Riley, formerly Professor of Community Health, University of Papua New Guinea, for his comprehensive review and for the checklist of suggested areas for review and to Dr P. Rosenfield, formerly Secretary, Scientific Working Group on Social and Economic Research, for her compilation and analysis of the many useful suggestions submitted.

APPENDIX 2 Estimating sample size for a prevalence study[a]

The size of sample needed for a prevalence study depends upon the accuracy required and the prevalence of the condition itself. For instance, leprosy may have a prevalence of around 1 per 100, or 10 per 1000 people. In a sample of 100 people, therefore, only 1 case would be expected and there is a reasonable chance that no cases at all would be observed. Thus, such a small sample is unlikely to give an accurate assessment of the leprosy prevalence rate. Even in a sample of 1000 people we would expect only 10 leprosy cases. For a more common condition, such as schistosomiasis with a prevalence of 30%, say, a sample of 100-200 people would give a reasonably accurate prevalence rate and examining as many as 1000 people would probably not be necessary.

If the sample is selected correctly, the larger the sample, the closer the estimate of prevalence in the sample is likely to be to the true prevalence in the whole community from which the sample is drawn. The smaller the sample, however, the smaller will be the time and resources required. Also supervision and quality control may be easier with a small sample, which will ensure the accuracy and repeatability of the information collected. Thus in a prevalence study, the sample size required is the smallest one that will give an estimate of prevalence with the desired degree of accuracy. The table on page 176 shows examples of minimum sample sizes for various levels of expected prevalence and specified margins of sampling error in the estimated prevalence.

To use this table, first select the appropriate column in the table according to how close to 50% the prevalence is expected to be. (If the figure is higher than 50%, use 100 minus the figure.) Then select the appropriate row in the table according to the amount of sampling error that can be tolerated in the estimated rate.

For example, if it is suspected that the prevalence of schistosomiasis is somewhere between 20% and 40% in the population and that a survey should have a good chance of estimating the prevalence to within 5% of the true value, it is necessary to examine a random sample of at least 369 people. When the survey is completed, if the sample shows a prevalence of 32.5% the range for the prevalence in the population (from which the sample was randomly drawn) is 32.5% plus or minus 5%, i.e. between 27.5% and 37.5%.

---

[a] For a more detailed discussion of sample size, see: Lwanga, S.K. & Lemeshow, S., *Sample size determination in health studies: a practical manual.* Geneva, World Health Organization (in press).

Minimum sample size for a prevalence survey according to expected prevalence rate

Margin of sampling error tolerated[1]	Maximum expected prevalence rate (%)[2]							
	1%	2.5%	5%	10%	20%	30%	40%	50%
0.5%	1 522	3 746	7 300	13 830	–	–	–	–
1%	381	937	1 825	3 458	6 147	8 068	9 220	9 604
2%	–	235	457	865	1 537	2 017	2 305	2 401
5%	–	–	73	139	246	323	369	385
10%	–	–	–	35	62	81	93	97
15%	–	–	–	–	28	36	41	43

[1] This represents the 95% confidence interval. For example, if the true prevalence was 10% and we took a sample of size 139 we would be 95% certain that the prevalence measured in the sample would be between 5% and 15% (i.e. 10 ± 5%). In general, do not accept a sampling error of greater than 5%.

[2] Select the highest rate that the prevalence is likely to be. If the rate is expected to be higher than 50%, use 100 minus the expected rate.

With a low-prevalence condition, such as leprosy, with a prevalence rate of 1-2%, it is likely that only a margin of error of 0.5% to 1% would be acceptable. Referring to the above table, a 1% error on an estimated prevalence of 2.5% would require a sample size of at least 937 people. In other words, for a district leprosy survey to give a reasonably accurate estimate of the prevalence rate of leprosy, the sample size will need to be 1000 or more people.

To work out the required sample size for values not shown in the table, use the following equation:

$$n = \frac{pq}{(E/1.96)^2}$$ where

n is the minimum sample size required

p is the maximum expected prevalence rate (%)

$q = 100 - p$

E is the margin of sampling error tolerated (%).

e.g. if $p = 40$; $q = 60$; $E = 5$:

$$n = \frac{(40 \times 60)}{(5/1.96)^2} = 368.8 \text{ or } 369 \text{ people}$$

APPENDIX 3 Using random numbers

In order to draw a random sample for a study population, the table of random numbers shown **overleaf** can be used. For example, if the reference population is living in 130 listed villages and it is intended to draw a random sample of 10 villages, then proceed as follows:

- Since the reference population is living in 130 villages we require three-figure numbers. Select any 3 adjacent single number columns between 1 and 40 (i.e. columns 11, 12 and 13).
- Run down these 3 columns and pick out the first 10 numbers between 1 and 130, i.e. first numbers are 48, 81, 72, etc.
- At the end of columns 11, 12 and 13 start again at the top of the next three, i.e. 14, 15, and 16.
- Proceed like this until 10 numbers have been selected. These numbers correspond to the numbers of the selected villages in the village listing.
- The same procedure can be followed for randomly selecting, for example, 10 or 20 people from each village. However, remember that you may want to define this sample more precisely, and only select children aged 0-4 years or all women aged 15-44 years or adults aged 15 years or more.

RANDOM SAMPLING NUMBERS

1	*10*	*11*	*20*	*21*	*30*	*31*	*40*
18 10 49 89 75		57 96 23 76 80		93 00 28 92 31		44 33 49 42 80	
50 89 75 71 55		27 63 29 98 47		38 94 60 09 62		61 42 86 50 58	
11 15 50 84 49		34 67 34 36 82		53 90 49 23 88		06 89 27 08 16	
70 25 51 01 81		16 19 30 09 68		02 21 05 62 33		45 95 87 67 47	
62 86 38 01 20		04 82 62 77 31		49 63 64 70 99		39 66 55 18 11	
95 19 70 36 92		85 05 39 25 78		84 34 14 28 76		20 20 17 79 94	
85 61 50 19 61		87 14 59 61 75		53 44 19 12 00		65 02 00 70 99	
83 55 66 76 74		68 47 68 66 86		49 47 63 51 43		87 42 58 36 04	
90 51 34 31 18		74 55 41 42 81		70 15 36 55 16		10 88 62 68 72	
99 56 78 99 98		77 87 25 77 60		34 13 82 02 11		32 31 43 48 10	
27 24 80 09 77		14 13 96 19 16		22 48 88 26 25		42 67 93 74 00	
34 63 66 89 97		29 99 91 27 17		14 56 41 05 32		90 14 45 30 61	
28 98 45 23 35		60 68 32 66 37		43 44 27 92 07		91 64 22 32 72	
06 96 34 21 67		08 12 58 74 35		91 64 68 15 01		36 52 07 00 39	
19 62 94 14 54		83 15 22 30 16		92 99 79 27 67		13 22 25 43 19	
44 36 96 82 39		55 96 96 89 04		43 89 96 59 17		10 84 24 12 44	
76 96 59 93 98		79 41 35 91 77		66 88 50 31 77		06 24 08 19 51	
31 61 97 08 88		35 43 85 84 51		94 85 55 05 33		86 42 20 51 41	
42 95 12 75 72		33 23 70 66 71		76 89 28 45 92		12 21 41 92 53	
95 42 30 03 62		83 35 78 07 35		67 85 83 57 36		96 97 62 67 06	
48 55 12 87 21		41 86 33 99 44		83 14 01 42 54		59 31 64 10 04	
46 18 81 87 56		81 03 74 48 49		28 37 85 93 69		84 92 33 52 70	
66 47 43 88 02		61 25 59 10 35		09 65 92 36 93		47 04 89 17 03	
61 91 88 50 00		19 31 08 80 39		14 03 80 46 41		78 82 03 69 52	
85 74 04 57 53		44 43 44 61 57		29 24 36 38 79		49 25 39 73 02	
89 09 53 94 07		92 21 54 01 70		31 91 39 51 03		94 83 98 31 15	
54 87 27 50 35		73 27 60 10 55		13 21 24 10 55		84 78 88 46 83	
49 13 89 98 96		21 02 44 94 30		50 70 71 02 16		35 31 13 14 45	
97 37 11 88 77		45 16 03 17 01		00 67 28 09 39		28 39 11 36 82	
99 70 37 54 02		40 71 13 59 37		84 38 47 11 31		48 92 28 96 37	
65 67 36 23 39		07 20 59 36 85		47 17 51 32 75		07 74 63 68 01	
53 69 94 34 45		46 09 52 84 40		82 80 75 72 79		43 97 07 96 15	
54 08 33 44 54		42 81 46 46 42		01 44 13 13 97		35 11 85 48 41	
95 54 39 60 78		27 35 07 35 53		93 29 83 01 86		52 11 41 68 50	
88 79 66 20 03		48 81 94 46 07		91 39 12 45 51		68 94 53 77 83	
68 82 57 41 23		57 52 47 09 83		11 27 88 40 16		22 64 86 22 18	
55 73 62 41 71		45 35 51 28 64		82 46 10 85 71		21 57 92 10 58	
17 50 60 03 20		35 64 36 90 97		29 78 17 83 29		08 99 20 47 79	
11 64 11 75 35		76 49 67 96 84		11 75 73 34 90		97 74 85 88 37	
78 32 11 34 33		55 30 20 68 10		68 96 94 82 04		94 10 52 73 51	

APPENDIX 4 Organizing an epidemiological survey

Before a survey or investigation is ready for implementation much preparatory work needs to be done. The administrative and organizational details must be dealt with before the fieldwork is started.

The procedures involved will be discussed under the following headings:

- Identifying the procedures required.
- Implementing the investigation.
- Supervising the fieldwork.

Identifying the procedures required

Although preliminary plans for the investigation will already have been made, it will be necessary to translate these into the specific procedures required to implement the survey. A useful checklist of the procedures involved can be obtained by answering a few questions.

Who will carry out the investigation?

An investigation usually involves a large number of people, often for considerable periods of time. The staff concerned should therefore be well organized so that the investigation can be conducted efficiently and in the shortest time possible.

To organize the staff, **job specifications** for the posts must first be prepared. This eliminates the risk of confusion concerning the roles of different staff and also ensures that all necessary tasks will be carried out.

Next, activities should be grouped and coordinated so that they can be performed most efficiently. This can only be done if proper **authority** or **hierarchical relationships** are established. These relationships provide for a group of activities to be placed under the supervision of one person—the "manager" or "supervisor". Instructions and other vital information can then be rapidly channelled through these supervisors to the most peripheral staff. A clear line of authority helps to harmonize working relationships within each group. Otherwise there will be a lot of time wasted, frustrations, a lack of coordination and duplicated efforts.

An effective way of clearly illustrating the line of authority is to draw up an **organizational chart**. This is a diagrammatic representation of the entire team showing the main lines of authority and

indicating how the different functions are linked together. A short **post description** for each post will clarify this even further. It should state the basic functions, major duties and scope of authority of a particular post.

A clear distinction should be made between the functions and authority delegated to **line** and **staff personnel**. A leader of **line personnel** (e.g. pesticide spray team leader) has a supervisory role and is directly responsible for the accomplishment of tasks assigned to that group. **Staff personnel** (e.g. evaluation team), on the other hand, have an advisory role with a basic function of assisting and advising line personnel. They should remain in an advisory capacity and not assume an executive role, e.g. instructing the line staff to implement their recommendations; if this happens, resentment may develop. Care must be taken to ensure that the staff personnel do not undermine the authority of the line personnel.

It is also important to **delegate authority** so as to permit staff to carry out their allocated duties. This will not only permit better coordination of the entire investigation but also help to train and develop promising junior staff. If insufficient authority is delegated, the subordinates will be hampered in carrying out their duties. If too much authority is delegated, the superior's position becomes redundant and control of the staff more difficult. A balance is essential for the efficient functioning of the investigation team.

A few other basic management principles should be followed to minimize problems. These include the concept of holding the superiors responsible for all organizational activities of subordinates. This follows the principle of granting **authority with responsibility**: those given authority over other staff should also be held responsible for their work performance. To ensure that there is no confusion, subordinates should be responsible to a single superior. Problems arise when they become accountable to more than one superior, as then they will have to divide their time and may find it hard to identify themselves with a particular job. Finally, it is also important to ensure that once authority has been **delegated**, it should be **exercised**. Decisions that have been delegated should be made by the person concerned. They should not be referred to the superior, nor should they be overruled unless there is a compelling reason to do so.

What is to be done?

A detailed **job description** should be carefully worked out for all staff involved. This enables the staff member concerned to know what is expected of him/her. The job description should also specify the work objectives in terms of quantity (e.g. thick and thin blood films to be collected from 50-80 persons per day), and quality (e.g. with a constantly low discrepancy rate never rising above 10% following re-examination of either positive or negative slides).

Where will the investigation take place?

Consideration should be given to both the physical location of the investigation and the population among whom the investigation is to take place.

Although the general area may have already been selected and the basis for selecting samples stated, the actual task of selecting the exact location of the investigation has still to be completed. It should, of course, be based upon the scientific considerations that have been predetermined. In practice, several constraints may make the predetermined selections impractical. A village, for example, selected purely by random sample, may be virtually inaccessible to the survey team, perhaps reachable only after a 30 km trek on foot. The periodic migratory pattern of the population may also rule out a particular area. The **accessibility** of an area must, therefore, form an important consideration in the selection of a community for investigation.

Geographical accessibility, however, does not always mean that the villagers can be contacted. The survey team may be able to get to them but they must also respond to its approaches. The **acceptability** of the investigation to the local community is thus equally important. Some investigations may be unacceptable because of local beliefs. Collection and removal of faecal samples, for example, is taboo in certain communities, as it is believed that the faeces can be used to harm the donor. Examination of the specimen may be permitted *in situ* under strict supervision, but the specimen cannot be taken away.

A thorough understanding of **local customs and culture** is therefore necessary. This helps not only to overcome existing problems, but also to prevent problems from arising in the future through sheer ignorance and insensitivity to local customs. Such an understanding can only be obtained through preliminary visits to the area. Some people may feel that these visits are superfluous as they assume that they already have a good understanding of the area and its people. Unfortunately this is not always correct. Cultural practices may vary markedly even in a relatively small area. Information obtained through written or verbal reports can never convey the same depth of understanding of the area as a personal visit. Time spent in the area can also be used to build up a close rapport with the **village leaders**. Meticulous attention to such apparently minor details may be crucial to the quality of the investigation.

When is the investigation to be done?

An investigation should be implemented according to specified target dates and completed within the **scheduled time**.

Before carrying out the investigation, check on the local conditions to ensure that there is no special local factor that would produce problems for the study. For example, the time of day could be important in many Melanesian villages which may be almost deserted at certain periods.

The **climate and season** are also important features. Field surveys during the rainy season may run into transportation and communication problems. Flooded rivers, impassable mud tracks and inadequate bridges are only some of the many possible problems. Maintenance and storage of equipment also becomes difficult in a situation where there is continuous heavy rain. The rain might also affect the vectors and animal reservoirs of disease, producing situations that are unrepresentative of the area for the most part of the year. This should have been considered during the planning stage, but it should be checked again before the study is started.

In rural, particularly agricultural, regions the different seasons also affect the activity and mobility of the population. Surveys carried out at planting or harvesting periods would elicit poor response rates as most of the people have to work in the fields. Therefore surveys may need to be carried out in the early morning and late afternoon and evening. Market days on the other hand could be either an advantage or disadvantage, depending upon the type of survey being made. The movements of the population in an area where markets are held regularly should be taken into consideration when planning visits for village-based studies.

Numerous other examples can be quoted. All point towards the importance of having a thorough knowledge of local customs, festivals, culture and other social factors.

How is the investigation to be done?

The methods by which data are to be collected (e.g. questionnaire) and recorded must be finalized. The number, content and design of all forms should also be finalized.

Training of all participating personnel is essential. Regular classroom and field sessions should be held. Free discussion and comments should be encouraged. Indeed many potential field problems may come to light during such sessions, especially when experienced field staff are present. At the end of the training session, a practical test could ensure that those who complete the training have attained the required level of skill. Such a test could include, for example, the identification of positive malaria slides from a pre-prepared set and the recording of a set of information. By such techniques the quality of the field investigators can be raised considerably, so that a fair degree of reliability of results can be achieved.

The manner in which questionnaires are administered can be crucial. Personnel can gain practice in using the questionnaire on

each other and on their own families. Only after a period of such classroom training should they go into the community to carry out a trial run. This very useful exercise can extend from one day, when testing out a series of methods, to a longer period if further decisions are to be made on organization of, say, data record forms or supply of specimens to the laboratory. Locations other than the intended study village should be selected for this purpose.

Training on the use of equipment should also be carried out. Calibration and standardization of all instruments will reduce measurement errors, e.g. in weighing machines.

The content of such training sessions should extend beyond technical skills. Such sessions should also be used to motivate the workers to a high level of interest and efficiency. This can be done by familiarizing them with the goals, objectives and components of the investigation. In particular, the importance of the study and the benefits that it will bring to the community should be stressed. In this way the field worker will feel that he or she is an essential team member of an important and useful study. In addition this feeling will be transmitted to the community through the workers in contact with them. If the workers are poorly motivated and show a lack of interest in their work, the community's opinion of the investigation will be adversely affected. Do not forget that as long as the team is in contact with the community, it is being constantly watched and assessed. If members show a lack of either interest or expertise, this will quickly be noted and a corresponding drop in the cooperation and participation of the community may be expected.

Relevant and ongoing training to reinforce both the quality of work and the motivation of the staff should form part of the programme. Any questionnaire that will be used in the survey should also be used in training.

Operational manuals can be very useful for the field workers, particularly for those working in remote areas with no immediate access to supervisory staff. These could also form the basis for training the staff and sufficient quantities should be prepared before the staff are sent out.

As discussed earlier, achieving a sympathetic relationship with the community is vital. Often enthusiasm will be kindled by the novelty of the project. As it wears off, the problems of maintaining or even improving upon the established links have to be faced. This can be tackled in a variety of ways. The basic philosophy underlying all methods should be to provide something needed by the community. In areas where no medical care is provided, the introduction of effective treatment services is one sure way of attracting and sustaining community participation. The key here is to ensure that the services provided are indeed effective and provide some benefits (preferably including some that are obvious to the community) to the

people participating in the scheme. If untoward reactions are blamed on the services provided (whether justified or not) then the opposite reaction, i.e. rejection of the investigation, may develop in the community. If additional services are provided, however, provision should be made for their continuation after the study is completed. Expectations must not be unduly raised. (See Appendix 1 for other ethical considerations concerning epidemiological studies in communities.)

Implementing the investigation

While the investigation is being planned and the study population identified, the local government authorities should also be informed. Whatever clearance is required from such authorities should be obtained. At times, the study areas selected may be experiencing internal security problems. In such circumstances, further clearance from higher authorities may have to be acquired.

When the necessary approval has been obtained, some publicity about the investigation may have to be arranged. This may take the form of visits to the leaders of the community to elicit support for the project, as well as to encourage them to spread the news of the project by word of mouth during community meetings or during prayer times (especially in Muslim areas). Announcements on local radio station broadcasts regarding the forthcoming survey can also be helpful. In rural areas, where literacy is low, newspapers will probably not be widely read.

Finally a visit should be made to the study population area before the start of the study. This visit should be conducted in the company of the community leaders, so that proper introductions can be made. This visit should have the objectives of reassuring the study population of the confidentiality of the information collected and also of motivating them to turn up for any necessary medical examinations or to be at home when field workers call. The visit can also serve to identify any problems that might produce a high non-response rate among the selected sample. Distribution of containers (e.g. for stool examination) can, moreover, be made during this visit.

Management of crowds

Large crowds may be expected, particularly during the early phases of the programme and in rural areas, where such an event could be talked about for months afterwards. Efficient crowd control is thus necessary. Spectators should be politely, but firmly, separated from respondents. Use of flow charts would expedite the handling of the respondents. Minimizing the waiting time and the total time spent by the respondents at the examination centre can go a long way towards ensuring the success of the investigation.

Collection of data

Basically, three types of data are collected in any investigation:

- Data obtained from the respondent or family, usually by questionnaires.
- Data obtained from examination of the respondent.
- Data from specimens collected from respondents, e.g. blood.

No matter how the data are obtained, they should be entered on a standard recording form which can subsequently be processed to produce the information required.

A unique identification number should be given to each respondent in the study. The same number should be used for the same respondent throughout. Avoid issuing different numbers for the same person as this will produce many problems in subsequently identifying the person and in data processing and tabulation.

Communication with the respondents is another vital aspect that can easily be overlooked. Always ensure that there are sufficient people present who can translate the local dialects for the team. Providing sufficient privacy and reassuring the respondent that all data obtained will be kept confidential will help to ensure a better and fuller response to questions.

Another important factor to keep in mind is that when any female patient is being examined, particularly a young woman, a female chaperone must be present throughout. This helps the respondent and the community to have confidence in the investigating team.

When any investigative procedure is planned (e.g. taking blood), the procedure and the investigations planned should be carefully explained. Careful attention should also be paid to the labelling and storage of specimens. The donor should be clearly identified on the specimen container in waterproof ink, and an effective glue should be used to ensure that the labels do not drop off during either the storage or processing stages. These rather obvious and simple precautions are often overlooked, resulting in problems that take considerable effort to overcome.

Supervising the fieldwork

Constant supervision and evaluation of the work done are an essential part of any investigation, as they help to ensure a good standard of work.

Check on methods used to collect data

The first thing to ensure is that what is being done is what was planned. Sometimes, despite all the repeated planning and training sessions, very basic facts and instructions are either distorted or

omitted. The field investigators may then introduce procedures that are neither acceptable nor uniform. What appears to be very simple and clear to the supervisors may actually be most confusing to the field investigator who may have little or no formal education. Therefore check all basic data collected to ensure that they are the data required and are being obtained in the manner prescribed. This is most important during the early stages of the investigations when problems are most likely to occur; at this stage corrective action can minimize the effect of any error introduced.

Check on how the work is being done

Once it has been established that the methods used are those recommended, check on how much (quantity) data are being collected and how well (quality).

In order to do this, standards must first be established for all tasks performed. These standards should reflect the nature and type of activity performed. They should be objective, accurate and expressed in terms that can measure the performance of the staff.

Supervision is necessary at various levels in the field, laboratory and elsewhere. It may be direct when a supervisor works as part of a group, usually made up of a number of teams, and accepts the responsibility for maintaining the standard of work. For example, the supervisor may issue a coloured flag to each of the teams, which is left at the entrance to the house or compound in order to locate them easily, thus facilitating a spot check visit by the supervisor or other senior personnel.

Supervision is also necessary in an indirect way, for example, during the review process of examining record forms filled in during the field activities. It is often found that a field worker is filling in the form incorrectly. A common error is to record a child's weight as 90 kg instead of 09 kg. Re-examination by one microscopist of a regular percentage of blood films examined by another is a form of indirect supervision or quality control.

Continuous supervision and evaluation will not only give an indication of how work is being carried out, but will also stimulate the field workers to produce better results, as they will know that their work is being constantly evaluated. Sometimes only limited supervision by senior team members is possible in the field, but one field worker may stand out in a group as having the respect of his or her fellow workers, the population and local officials, and can be given the post of field supervisor.

Check on how work may be improved

Finally, never assume that the procedures and techniques that have been planned will produce the desired results. All stages of even the most carefully planned investigations may need to be improved

upon, particularly once the fieldwork has started. However, before any changes are made, the DHMT should consider whether **reorientation or retraining** is necessary.The DHMT should allow for the possibility that changes may be needed and should arrange for them to be included in the relevant manual of working instructions.

Pilot trials can also help to solve logistic and administrative problems. For example, the amount of transport required, the techniques of specimen preservation and storage to be adopted, the adequacy of working and living conditions, and the setting of a realistic time schedule can all be evaluated and improved upon by using information gathered from a pilot study.

All data should be checked as they are collected and reviewed each day. Simple tabulations should be done every day. If possible the data obtained should be analysed and problems identified. Adjustments to existing plans should be introduced whenever necessary, to overcome any problems found. Staff meetings can help in identifying these solutions. Sometimes it may help to repeat the trial runs in order to produce valid information. However, such runs need not stretch over a long period, but can be scheduled to last one or two days only.

APPENDIX 5 Screening and diagnostic tests

Validity

Screening and diagnostic tests may be based on standardized interviews, physical examinations or laboratory tests, or on more sophisticated measurements such as radiography, electrocardiography, slitlamp examinations of the eye, sonography, and histopathology. In the selection of the test and the criteria to be applied, the epidemiologist has to consider the **validity** and the **predictive value** of the different methods.

The validity of the test refers to the extent to which the test is capable of correctly diagnosing the presence or absence of the disease concerned. These two aspects are referred to respectively as the **sensitivity** and the **specificity** of the test. For example, a test is said to have a sensitivity of 90% if it gives a positive result in 90% of persons who actually have the disease. On the other hand, a test is said to have a specificity of 90% if it gives a negative result in 90% of persons who actually do not have the disease. Examples that illustrate sensitivity and specificity are shown below.

The test under consideration is always compared to the "true" situation, as shown in the following table:

		Test result		
		positive	*negative*	*total*
True disease	*present*	a	b	a + b
	absent	c	d	c + d
Total		a + c	b + d	a + b + c + d

Sensitivity	=	$\frac{a}{a+b}$	Specificity	=	$\frac{d}{c+d}$
False negatives	=	b	False positives	=	c
True prevalence of disease or condition	=	$\frac{a+b}{a+b+c+d}$			

when a + b + c + d is a representative sample of the population

$$\text{Positive predictive value of test} = \frac{a}{a+c}$$

$$\text{Negative predictive value of test} = \frac{d}{b+d}$$

Sensitivity and specificity are ratios comparing test results to the "true" disease situation. However, tests are actually used the other way around when they are needed to predict which individuals have the disease or condition being investigated – hence the importance of the positive and negative "predictive values".

Predictive value

Tests are generally judged on the basis of their sensitivity and specificity. Such evaluations are essential, but they may not provide all the information that a user of a test may need to make decisions concerning the best strategy for the particular circumstances under consideration. The **predictive value** of a test, which depends upon the prevalence of the disease or condition, as well as the test's sensitivity and specificity, is the most important measure for determining its usefulness under field conditions.

The equation below shows the relationship between sensitivity, specificity and positive predictive value:

$$PV(+) = \frac{P \times S_1}{(P \times S_1) + ((1 - P) \times (1 - S_2))}$$

Where: P is the prevalence of the disease or condition

S_1 is the sensitivity and S_2 the specificity of the test.

The corresponding equation for the likelihood that a test-negative person actually does not have the disease is:

$$PV(-) = \frac{(1-P) \times S_2}{((1-P) \times S_2) + (P \times (1 - S_1))}$$

These equations can be used to calculate predictive values for different combinations of test sensitivity and specificity and disease prevalence.

Predictive value and different prevalence rates

Consider, for example, a diagnostic test that has a sensitivity of 95% and a specificity of 95%. If this test is used in a population where the prevalence of disease is 20%, the predictive value of a positive result is 83%, calculated by the above equation thus:

$$PV(+) = \frac{0.2 \times 0.95}{(0.2 \times 0.95) + (0.8 \times 0.05)} = 0.83 \text{ or } 83\%$$

When this same test is used in a population where the prevalence of disease is only 1%, the predictive value of a positive result is only 16%, as obtained by the same equation thus:

$$PV(+) = \frac{0.01 \times 0.95}{(0.01 \times 0.95) + (0.99 \times 0.05)} = 0.16 \text{ or } 16\%$$

This means that of all the positives found by the screening test only 16%, or about 1 in 6, are true positives.

Predictive value and disease control programmes

This example shows that even for a test of fairly high sensitivity and specificity, the predictive value of a positive result will fall dramatically from 83% to 16% when the prevalence of disease falls from 20% to 1%, a situation which can occur when a control programme has been successfully implemented.

If this test is applied to a sample of 2000 persons of known disease status on both occasions, the expected distribution of test results in relation to actual disease can be shown in the form of 4-fold tables, as shown below:

Before control the prevalence rate is 20%, so that 400 out of 2000 have the disease.

		Test result		
		positive	*negative*	*total*
Disease present	*yes*	380	20	400
	no	80	1520	1600
	total	460	1540	2000

Test sensitivity = 95% (380/400)

Test specificity = 95% (1520/1600)

*Positive predictive value is 380/460 = 83%

* Note that the positive predictive value can be calculated directly from the figures in these tables only when the numbers of persons with and without disease reflect the true prevalence in the population.

After a successful control programme the prevalence rate drops to 1%, so that 20 out of 2000 have the disease.

		Test result		
		positive	*negative*	*total*
Disease present	*yes*	19	1	20
	no	99	1881	1980
	total	118	1882	2000

Test sensitivity = 95% (19/20)
Test specificity = 95% (1881/1980)
*Positive predictive value is 19/118 = 16%

Thus, before the control programme, nearly everyone who had a positive test actually had the disease or condition; when the prevalence was reduced to 1% only about 1 in 6 of those with a positive test actually had the disease or condition. Before the control programme there were fewer than 20% false positive results whereas after the programme more than 80% of the positive test results were false; yet there was no change in the test sensitivity or specificity.

It may also be noted that when the true prevalence rate was 20%, the test yielded 460 positive results, giving an apparent prevalence rate (observed) of 23%. When the true prevalence rate fell to 1%, the test yielded 188 positive results, giving an apparent prevalence rate (observed) of 5.9%, which is nearly six times higher than the true rate.

Recognition of changes in predictive values of test results which are due to changes in prevalence is also important for selection of intervention procedures, both for the individual patient (e.g. selective chemotherapy for schistosomiasis) and for community programmes (e.g. mass chemotherapy for lymphatic filariasis or continued zonal spraying for onchocerciasis). What are the relative costs, risks and benefits of the particular decision either to treat an individual or community showing a false positive result or not to treat if the result is a false negative? It may be useful to change the diagnostic approach when the prevalence drops, e.g. perhaps to a multistage programme with a sensitive screening test followed by a more specific (and probably more costly) test. Note that to increase the predictive value of a positive test an increase in the specificity will be more effective than a similar increase in sensitivity.

APPENDIX 6 Age standardization

This is an example showing that wrong conclusions can be drawn if crude, or unstandardized, infection prevalence rates are used.

When there are differences in age structure between two populations, there are two methods of standardization available which are easy to use and which are explained below:

- Age-specific rates.
- Direct age standardization.

Example: Two villages, endemic for schistosomiasis, each have a population of 500 people who were examined for the presence of *Schistosoma mansoni* eggs in faecal specimens. The statement was made that the two populations were similar with respect to their total population, age range and male to female sex ratio. The overall prevalence rates for the total population in villages A and B are shown in the following table:

Comparison of crude prevalence rate of* Schistosoma mansoni *infection in Villages A and B

Age (years)	*Village A*			*Village B*			*Standard population (A + B)*
	No. examined	*No. positive*	*% positive*	*No. examined*	*No. positive*	*% positive*	
0-4	50	5	10	50	5	10	100
5-9	100	40	40	50	20	40	150
10-14	150	120	80	50	40	80	200
15-19	80	56	70	80	56	70	160
20-29	70	21	30	120	36	30	190
30+	50	10	20	150	30	20	200
TOTAL	500	252	50.4	500	187	37.4	1000

$$\text{Difference between the two rates} = \frac{50.4 - 37.4}{\text{Standard error of difference}} = 4.2, \quad P < 0.01$$

As the difference between the rates for the two villages (50.4% and 37.4% respectively) was statistically different, it was concluded that there was a true difference in the endemicity of schistosomiasis. That is, village A was more heavily infected than village B.

Using age-specific rates

While it is true that the total prevalence rates (expressed as percentages) for the two villages were significantly different, all the age-specific rates were exactly the same for both villages (see third column for each village). As the investigators looked only at the total prevalence rate and not at the age-specific rates, their interpretation was biased. They did not control for differences in the age composition of the two populations. The peak infection rate among teenagers and the fact that there were more people in village A in the 10-14-year age group led to a higher rate for the total percentage.

Using direct age standardization

There are four main steps:

1. Calculate incidence or prevalence rates for each age group,

   e.g. for 0-4 year olds in village A:

$$\text{Prevalence rate} = \frac{5 \times 100}{50} = 10\%$$

2. Form a new standard population for each age group by adding populations A + B see the last column in the table.
3. Age-specific rates for A and B are multiplied by the standard population to give the expected total number of infected people in that age group, e.g. the number for village A 10-14 year olds is

$$\frac{80 \times 200}{100} = 160$$

4. If this process is completed for each age group and for each village it will be found that, for each village, given the standard age structure, there would be an expected 439 cases.

$$\text{Prevalence rate} = \frac{\text{Total expected cases}}{\text{Total standard population}} \times 100$$

$$= \frac{439 \times 100}{1000} = 43.9\%$$

Thus, age standardization shows that there is no difference between villages A and B and therefore the original conclusion was incorrect.

Conclusion

The above example shows how use of age-specific rates and direct age standardization can prevent incorrect conclusions from being drawn. In this example, an apparent difference between villages A and B was found not to exist when these methods were used. However, the reverse can also happen: an apparently insignificant difference can become statistically significant after standardization, but this effect is less common than the one demonstrated above.

Index