Chapter 6
Epidemiology and prevention: chronic noncommunicable diseases

Key messages

- Chronic noncommunicable diseases are major public health challenges in most countries.
- The causes of chronic diseases are generally known and cost-effective interventions are available.
- A comprehensive approach is required for the prevention and control of these diseases.
- Ultimately, primary prevention and control is the best strategy for the prevention of modern epidemics.
- Targeting high-risk individuals with secondary and tertiary prevention are also ways to reduce the burden of chronic disease.

The scope of prevention

The decline in death rates that occurred during the nineteenth century in high-income countries was principally due to a decrease in deaths from infectious disease. Figure 6.1 shows tuberculosis death rates in England and Wales for the period 1840–1968 and indicates the times of introduction of specific preventive and therapeutic measures. Most of the decline in mortality took place before these interventions and has been attributed to improvements in nutrition, housing, sanitation and other environmental health measures.

Recent trends in death rates

In the last decades of the twentieth century, the declines in death rates from cardiovascular disease have accelerated in high-income countries. Since the 1970s, death rates from heart disease and stroke have fallen by up to 70% in Australia, Canada, Japan, the United Kingdom and the United States of America. There have also been improvements in cardiovascular mortality rates in middle-income countries, such as Poland. These gains have been the result of a wide range of measures directed at both whole populations and individuals. The preventive potential for chronic diseases is enormous. (Box 6.1). A decline in death rates of an additional 2% per annum over 10 years has the potential to avert the untimely deaths of 35 million people.
The respective contributions of chronic and infectious conditions to total mortality has changed in the last century. For example, in Brazil infectious diseases accounted for 45% of all deaths in 1930, but only 5% in 2003 (Figure 6.2). In contrast, the proportion attributed to cardiovascular diseases increased from 12% in 1930 to 31% in 2003.

However, mortality rates are influenced over time by the changing age structure of the population, as well as by waxing and waning epidemics. The changes in mortality rates in high-income countries have been particularly dramatic in the youngest
age groups, where infectious diseases used to account for most mortality. Traffic accidents are now the leading cause of death in childhood in many high-income countries.

Preventive potential

The changing patterns of mortality and morbidity indicate that major causes of disease are preventable. Yet even the healthiest person will succumb at some age, and the lifetime mortality risk for any population is 100%. However, most populations are affected by specific diseases which can be prevented. Studies of migrants show that they often develop the patterns of disease of host populations. For example, the rates of gastric cancer in people born in Hawaii to Japanese parents are lower than those of people born in Japan. After two generations in the USA, people of Japanese heritage have the same gastric cancer rate as the US population in general. The fact that it takes a generation or more for the rates to fall suggests the importance of an exposure – such as diet – in early life.

Geographical variation in disease occurrence within and between countries also provides important clues to preventive potential (Figure 6.3). In the United Kingdom age-standardized male lung cancer rates fell from 18 per 100,000 in 1950
to 4 per 100 000 by 2000. In contrast, over the same period of time in France, male lung cancer rates increased. In France, the increase in tobacco use occurred some decades later than in the United Kingdom, and smoking rates started to decrease only after 1990. Similarly, global lung cancer rates in women continue to rise, but this increase has been avoided in the United Kingdom.10

Causation framework

Epidemiology helps to identify modifiable causes of disease. Fifty years of epidemiological studies of coronary heart disease have identified much about the causes, from individual risk factors to cellular mechanisms in the arterial wall. However, the large differences between populations in risk factor levels are still not well understood. Causal inference needs to account both for disease-causation in the individual and for the social, economic, environmental and political contributions – the so-called upstream determinants – that are beyond the control of individuals (Figure 6.4).

Social determinants of health

The social determinants of health are the conditions in which people live and work.14 Addressing the social determinants of health is the fairest way to improve health for all people. Good medical care is vital, but the factors that can undermine people’s health – such as social position, housing conditions and occupational risks – need to be addressed to achieve equitable wellbeing15,16. Unfavourable social and environmental conditions may also lead to adverse behaviours, which can affect the levels of major risk factors for the main chronic diseases (Figure 6.4).
Public health nurses, medical sociologists, psychologists, health economists, ergonometrists, sanitary engineers, pollution control experts and occupational hygienists are all involved in disease-prevention efforts. As the limits of curative medicine become apparent and the costs of medical care escalate in all countries, disease prevention is gaining prominence.

Levels of prevention

The four levels of prevention, corresponding to different phases in the development of disease, are primordial, primary, secondary and tertiary.

Each of these levels targets factors or conditions which have an established role in causing disease. In situations where the evidence of such a role is incomplete, but the risk of not preventing a public health threat is deemed too high, preventive actions may still be taken and can be labelled “precautionary prevention.” This approach is common in the environmental field, where the “precautionary principle” is used to avoid public health risks from processes or products.17

Approaches to prevention overlap and merge, yet all levels are important and complementary. Primordial and primary prevention contribute most to the health of the whole population, while secondary and tertiary prevention are generally focused on people who already have signs of disease (Table 6.1).

Primordial prevention

This level of prevention was identified as a result of increasing knowledge about the epidemiology of cardiovascular diseases. It is known that coronary heart disease occurs on a large scale only if the basic underlying cause is present, i.e. a diet high in saturated animal fat. Where this cause is largely absent – as in China and Japan – coronary heart disease remains a rare cause of mortality and morbidity, despite the high frequencies of other important risk factors such as cigarette smoking and high blood pressure. However, smoking-induced lung cancer is on the increase and strokes induced by high blood pressure are common in China and Japan. In some middle-income countries, cardiovascular disease is becoming important in the urban middle- and upper-income groups, who have already acquired high-risk behaviour. As socioeconomic development occurs, such risk factors can be expected to become
more widespread. The aim of primordial prevention (Box 6.3) is to avoid the emergence and establishment of the social, economic and cultural patterns of living that are known to contribute to an elevated risk of disease.

The importance of primordial prevention is often realized too late. All countries need to avoid the spread of unhealthy lifestyles and consumption patterns. Primordial prevention of chronic disease should include national policies and programmes on nutrition. Such programmes need to involve the agricultural sector, the food industry and the food import/export sector. Countries also need programmes to promote regular physical activity. The example of tobacco use indicates that a high level of government commitment is required for effective primordial prevention. There is good evidence that tobacco consumption can be reduced by taxation and increased prices (Figure 6.5). The epidemiological evidence showing the harmful effects of tobacco use ultimately led to the Framework Convention on Tobacco Control in February 2006, the first health treaty adopted by the Member States of the World Health Organization (see Chapter 10).

### Box 6.3. Preventing air pollution

Primordial prevention is needed to counter the global effects of air pollution, such as the greenhouse effect, acid rain, ozone-layer depletion and the health effects of smog. Atmospheric particulate matter and sulfur dioxide concentrations in many major cities exceed the maximum recommended by the World Health Organization and the United Nations Environment Programme (UNEP). Cities in low- and middle-income countries that rely on coal as an energy supply are particularly affected. Public policies aimed at preventing these hazards are needed in most countries to protect health (see Chapter 9). Primordial prevention includes city planning that separates industrial from residential areas, facilitates public or “active” transport (walking, bicycling) and encourages energy conservation.

<table>
<thead>
<tr>
<th>Level</th>
<th>Phase of disease</th>
<th>Aim</th>
<th>Actions</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primordial</td>
<td>Underlying economic, social, and environmental conditions leading to causation</td>
<td>Establish and maintain conditions that minimize hazards to health</td>
<td>Measures that inhibit the emergence of environmental, economic, social and behavioural conditions.</td>
<td>Total population or selected groups; achieved through public health policy and health promotion.</td>
</tr>
<tr>
<td>Primary</td>
<td>Specific causal factors</td>
<td>Reduce the incidence of disease</td>
<td>Protection of health by personal and communal efforts, such as enhancing nutritional status, providing immunizations, and eliminating environmental risks.</td>
<td>Total population, selected groups and healthy individuals; achieved through public health policy.</td>
</tr>
<tr>
<td>Secondary</td>
<td>Early stage of disease</td>
<td>Reduce the prevalence of disease by shortening its duration</td>
<td>Measures available to individuals and communities for early detection and prompt intervention to control disease and minimize disability (e.g. through screening programs).</td>
<td>Individuals at high risk and patients; achieved through preventive medicine.</td>
</tr>
<tr>
<td>Tertiary</td>
<td>Late stage of disease (treatment, rehabilitation)</td>
<td>Reduce the number and/ or impact of complications</td>
<td>Measures aimed at softening the impact of long-term disease and disability; minimizing suffering; maximizing potential years of useful life.</td>
<td>Patients; achieved through rehabilitation.</td>
</tr>
</tbody>
</table>
Primary prevention

The purpose of primary prevention is to limit the incidence of disease by controlling specific causes and risk factors. Primary prevention efforts can be directed at:

- the whole population with the aim of reducing average risk (the population or “mass” strategy); or
- people at high risk as a result of particular exposures (the high-risk-individual strategy).

Population strategy

The population approach aims to shift the whole population distribution to the left on an imaginary x-axis; i.e. to reduce the mean population level of cholesterol (or blood pressure). The major advantage of the population strategy is that one does not have to identify the high-risk group but simply aim to reduce – by a small amount – the level of a given risk factor in the entire population. Its main disadvantage is that it offers little benefit to many individuals because their absolute risks of disease are quite low. For example, most people will wear a seat-belt while driving a car for their entire life without being involved in a crash. The widespread wearing of seat-belts has been very beneficial to the population as a whole, but little apparent benefit is accrued by those individuals who are never personally involved in a crash. This phenomenon has been called the prevention paradox.18

The high incidence of cardiovascular disease in most industrialized countries is due to the high levels of risk factors in the population as a whole, not to the problems
of a minority. The relationship between serum cholesterol and the risk of coronary heart disease (Figure 6.6), shows that the distribution of cholesterol is skewed a little to the right. Only a small minority of the population have a serum cholesterol level above 8 mmol/l, i.e. a very high risk of coronary heart disease. Most of the deaths attributable to coronary heart disease occur in the middle range of the cholesterol level, where most of the population is. In this case, primary prevention depends on changes that reduce the average risk in the whole population, thus shifting the whole distribution to a lower level.

Figure 6.7 compares the distribution of total cholesterol in three populations with different means. There is little overlap between people with high cholesterol levels in population A and population C. People with high cholesterol in population A would be considered to have low levels in population C.

These data come from the WHO MONICA (MONItoring of trends and determinants in CArdiovascular disease) Project, which comprised population surveys done at least twice in a decade in 38 geographically defined populations in 21 countries. The figure also illustrates the principle that any cut-off point for determining prevalence is arbitrary, but shifting the population mean by a small amount has a large impact. Shifting the population distribution from high levels to low levels is the purpose of primary prevention. In Figure 6.7, we can observe that:

- Population A with low mean cholesterol (4.0 mmol/l) also has a low prevalence of hypercholesterolaemia (6%), even if the cut-off point for determining prevalence is set at ≥ 5.0 mmol/l.
• Population B with a mean cholesterol of 5.4 mmol/l would classify almost two thirds of the population (64%) as having “high” cholesterol if the cut-off point were ≥ 5.0 mmol/l, but only 15% if the cut-off point were 6.2 mmol/l.
• The area under the curve in population C includes almost everyone if the cut-off point is set as low as ≥ 5.0 mmol/l.

Figure 6.7. Total cholesterol (mmol/l) distribution in three populations: A (low), B (average) and C (high).

<table>
<thead>
<tr>
<th>Population</th>
<th>Mean (sd) cholesterol (mmol/l)</th>
<th>Prevalence of hypercholesterolaemia</th>
</tr>
</thead>
</table>
| A (low)    | 4.0 (1.01)                     | ≥ 5.0 mmol/l: 6%  
|            |                                | ≥ 6.5 mmol/l: 2%            |
| B (average)| 5.4 (1.05)                     | ≥ 5.0 mmol/l: 64%  
|            |                                | ≥ 6.5 mmol/l: 15%           |
| C (high)   | 6.2 (0.95)                     | ≥ 5.0 mmol/l: 93%  
|            |                                | ≥ 6.5 mmol/l: 39%           |

Prevalence of hypercholesterolaemia

High-risk individual strategy

The alternative approach is to focus on individuals above an arbitrary cut-off point in an attempt to reduce the cholesterol levels in those individuals. Although the high-risk-individual strategy (which aims to protect susceptible persons) is most efficient for the people at greatest risk of a specific disease, these people may contribute little to the overall burden of the disease in the population. However, if people with established disease are included in this high-risk group, the strategy will contribute more to the overall reduction in the burden of disease (Box 6.4). The main disadvantage of the high-risk-individual strategy is that it usually requires a screening programme to identify the high-risk group, something that is often difficult and costly. Table 6.2 lists the advantages and disadvantages of the two strategies.

Combining the population strategy and a high-risk strategy is useful in many situations. Table 6.3 compares both approaches to the prevention of diabetes and obesity. The high-risk strategy is also more relevant when focused on individuals at high overall risk rather than those at high risk in terms of a single risk factor. For example, decisions

Box 6.4. High-risk strategy: smoking cessation

Smoking cessation programmes provide an excellent example of a high-risk strategy and are appropriate since most smokers wish to abandon the habit; thus individual smokers and the physicians concerned are usually strongly motivated. The benefits of intervention directed at high-risk individuals are likely to outweigh any adverse effects, such as the short-term effects of nicotine withdrawal. If the high-risk strategy is successful, it also benefits nonsmokers by reducing their passive smoking. Such programmes are more likely to be effective when complemented by population approaches to tobacco control.
Secondary prevention aims to reduce the more serious consequences of disease through early diagnosis and treatment. It comprises the measures available to individuals and populations for early detection and effective intervention. It is directed at the period between the onset of disease and the normal time of diagnosis, and aims to reduce the prevalence of disease.

Secondary prevention can be applied only to diseases in which the natural history includes an early period when it is easily identified and treated, so that progression to a more serious stage can be stopped. The two main requirements for a useful secondary prevention programme are a safe and accurate method of detecting the disease – preferably at a preclinical stage – and effective methods of intervention.
Cervical cancer provides an example of the importance of secondary prevention and of the difficulties of assessing the value of prevention programmes.

Figure 6.8 shows an association between screening rates and reductions in the death rate from cervical cancer in selected Canadian provinces in the 1970s. The data were initially questioned because the mortality rates for cervical cancer were already decreasing before organized screening programmes started. Other studies have since supported the value of such screening programmes, which are now widely applied in many – but not all – countries. Few low- and middle-income countries have the infrastructure for organized screening programs, and most women in low-income countries do not have access to routine screening. With the advent of an effective vaccine for human papillomavirus, cervical cancer is likely to become an example of a disease for which primary prevention measures predominate.

Other examples of secondary prevention measures that are widely used include testing of eyesight and hearing in school-age children, screening for high blood pressure in middle age, testing for hearing loss in factory workers, and skin testing and chest radiographs for the diagnosis of tuberculosis.

**Tertiary prevention**

Tertiary prevention is aimed at reducing the progress or complications of established disease and is an important aspect of therapeutic and rehabilitation medicine. It consists of the measures intended to reduce impairments and disabilities, minimize suffering caused by poor health and promote patients’ adjustment to incurable conditions. Tertiary prevention is often difficult to separate from treatment, since the treatment of chronic disease has as one of its central aims the prevention of recurrence.
The rehabilitation of patients with poliomyelitis, strokes, injuries, blindness and other chronic conditions is essential to their ability to take part in daily social life. Tertiary prevention can improve individual and family well being and income. An important aspect of tertiary prevention – particularly for younger people afflicted by illness or injury – is restoring their ability to work and earn a livelihood. If welfare systems are not functioning, even a temporary period of ill-health may cause severe economic hardship for the patient and his or her family. Epidemiological studies need to include the economic situation of people with ill-health as one of the crucial social determinants of health outcomes.

**Screening**

Screening people for disease – or risk factors which predict disease – is motivated by the potential benefits of secondary prevention through early detection and treatment.

**Definition**

Screening is the process of using tests on a large scale to identify the presence of disease in apparently healthy people. Screening tests do not usually establish a diagnosis, but rather the presence or absence of an identified risk factor, and thus require individual follow-up and treatment. As the recipients of screening are usually people who have no illness it is important that the screening test itself is very unlikely to cause harm. Screening can also be used to identify high exposure to risk factors. For instance, children’s blood samples can be screened for lead in areas of high use of lead in paint.

**Box 6.5. Targeted screening**

When targeted screening is done in groups with occupational exposures, the criteria for screening are not necessarily as strict as those for general population screening. The health effect that is prevented may be minor (nausea or headache), but screening may be a high priority if the effect reduces the patient’s ability to work. Many health effects from exposure to environmental hazards are graded, and preventing a minor effect may also prevent more serious effects. Targeted screening can be legally required – for example, in miners or people working with lead or chromium – and used in the follow-up to environmental pollution incidents, such as methyl-mercury poisoning (Minamata disease) in Japan in the 1960s (see Chapter 1 and Chapter 9).

**Types of screening**

There are different types of screening, each with specific aims:

- **mass screening** aims to screen the whole population (or subset);
- **multiple or multiphasic screening** uses several screening tests at the same time;
- **targeted screening** of groups with specific exposures, e.g. workers in lead battery factories, is often used in environmental and occupational health (Box 6.5); and
- **case-finding or opportunistic screening** is aimed at patients who consult a health practitioner for some other purpose.

**Criteria for screening**

*Table 6.4* lists the main criteria for establishing a screening programme. These relate to the characteristics of the disorder or disease, its treatment and the screening test.
Above all, the disease should be one that would prove serious if not diagnosed early; inborn metabolic defects such as phenylketonuria meet this criterion, as do some cancers, such as cancer of the cervix.

### Table 6.4. Requirements for instituting a medical screening programme

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Well-defined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence</td>
<td>Known</td>
</tr>
<tr>
<td>Natural history</td>
<td>Long period between first signs and overt disease; medically important disorder for which there is an effective remedy</td>
</tr>
<tr>
<td>Test choice</td>
<td>Simple and safe</td>
</tr>
<tr>
<td>Test performance</td>
<td>Distributions of test values in affected and unaffected individuals known</td>
</tr>
<tr>
<td>Financial</td>
<td>Cost-effective</td>
</tr>
<tr>
<td>Facilities</td>
<td>Available or easily provided</td>
</tr>
<tr>
<td>Acceptability</td>
<td>Procedures following a positive result are generally agreed upon and acceptable to both the screening authorities and to those screened.</td>
</tr>
<tr>
<td>Equity</td>
<td>Equity of access to screening services; effective, acceptable and safe treatment available</td>
</tr>
</tbody>
</table>

In addition, several issues need to be addressed before establishing a screening programme.

**Costs**
The costs of a screening programme must be balanced against the number of cases detected and the consequences of not screening. Generally, the prevalence of the preclinical stage of the disease should be high in the population screened, but occasionally it may be worthwhile to screen even for diseases of low prevalence which have serious consequences, such as phenylketonuria. If children with phenylketonuria are identified at birth, they can be given a special diet that will allow them to develop normally. If they are not given the diet, they become mentally retarded and require special care throughout life. In spite of the low incidence of this metabolic disease (2–4 per 100 000 births), secondary prevention screening programmes are highly cost-effective.

**Lead time**
The disease must have a reasonably long lead time; that is, the interval between the time when the disease can be first diagnosed by screening and when it is usually diagnosed in patients presenting with symptoms. Noise-induced hearing loss has a very long lead time; pancreatic cancer usually has a short one. A short lead time implies a rapidly progressing disease, and treatment initiated after screening is unlikely to be more effective than that begun after the more usual diagnostic procedures.

**Length bias**
Early treatment should be more effective in reducing mortality or morbidity than treatment begun after the development of overt disease, as, for example, in the treatment of cervical cancer in situ. A treatment must be effective and acceptable to people who are asymptomatic. If treatment is ineffective, earlier diagnosis only increases the
time period during which the participant is aware of the disease; this effect is known as length bias or length/time bias.

**Screening test**
The screening test itself must be cheap, easy to apply, acceptable to the public, reliable and valid. A test is reliable if it provides consistent results, and valid if it correctly categorizes people into groups with and without disease, as measured by its sensitivity and specificity.

- **Sensitivity** is the proportion of people with the disease in the screened population who are identified as ill by the screening test. (When the disease is present, how often does the test detect it?)
- **Specificity** is the proportion of disease-free people who are so identified by the screening test. (When the disease is absent, how often does the test provide a negative result?)

The methods for calculating these measures and the positive and negative predictive values are given in Table 6.5.

Although a screening test ideally is both highly sensitive and highly specific, we need to strike a balance between these characteristics, because most tests cannot do both. We determine this balance by an arbitrary cut-off point between normal and abnormal. If we want to increase sensitivity and to include all true positives, we are obliged to increase the number of false positives, which means decreasing specificity. Reducing the strictness of the criteria for a positive test can increase sensitivity, but by doing this the test’s specificity is reduced. Likewise, increasing the strictness of the criteria increases specificity but decreases sensitivity. We also need to account for predictive value when interpreting the results of screening tests.

<table>
<thead>
<tr>
<th>Disease status</th>
<th>Present</th>
<th>Absent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Screening test</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>a</td>
<td>b</td>
<td>a+b</td>
</tr>
<tr>
<td>Negative</td>
<td>c</td>
<td>d</td>
<td>c+d</td>
</tr>
<tr>
<td>Total</td>
<td>a+c</td>
<td>b+d</td>
<td>a+b+c+d</td>
</tr>
</tbody>
</table>

\[ a = \text{No. of true positives}, \quad b = \text{No. of false positives}, \]
\[ c = \text{No. of false negatives}, \quad d = \text{No. of true negatives} \]

- **Sensitivity** = probability of a positive test in people with the disease
  \[ = \frac{a}{a+c} \]
- **Specificity** = probability of a negative test in people without the disease
  \[ = \frac{d}{b+d} \]
- **Positive predictive value** = probability of the person having the disease when the test is positive
  \[ = \frac{a}{a+b} \]
- **Negative predictive value** = probability of the person not having the disease when the test is negative
  \[ = \frac{d}{c+d} \]
Decisions on the appropriate criteria for a screening test depend on the consequences of identifying false negatives and false positives. For a serious condition in newborn children, it might be preferable to have high sensitivity and to accept the increased cost of a high number of false positives (reduced specificity). Further follow-up would then be required to identify the true positives and true negatives.

**Natural history**

Above all, establishing appropriate criteria requires considerable knowledge of the natural history of the disease in question and of the benefits and costs of treatment. Adequate facilities must exist for formal diagnosis, treatment and follow-up of newly diagnosed cases, which could otherwise overwhelm the health services. Finally, the screening policy and programme must be accepted by all the people involved: administrators, health professionals and the public.

**Impact**

The value of a screening programme is ultimately determined by its effect on morbidity, mortality and disability. Ideally, information should be available on disease rates in people whose disease was identified through screening and in those whose disease was diagnosed on the basis of symptoms. Because differences are likely to exist between people who take part in screening programmes and people who do not, the best evidence for the effectiveness of screening comes from the results of randomized controlled trials (Box 6.6).

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**Box 6.6. Breast cancer screening: a case study**

A randomized controlled trial of 60 000 insured women aged 40–64 who were followed for up to 23 years found that mammography was effective in reducing mortality from breast cancer (Table 6.6). Ten years after entry into the study, the breast cancer mortality was about 29% lower among women who were screened than among those who had not; at 18 years, the rate was about 23% lower.

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<table>
<thead>
<tr>
<th>Table 6.6. Breast cancer mortality rates at follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of women with breast cancer</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Screened group</td>
</tr>
<tr>
<td>Control group</td>
</tr>
<tr>
<td>% difference</td>
</tr>
</tbody>
</table>

This relative reduction in mortality from breast cancer of 23%–29% looks less impressive when considered in absolute terms (the absolute mortality reduction was 0.05% of women screened). Another randomized control trial from the Swedish National Health Board showed a relative benefit of similar magnitude (31%), but also indicated that this represented a net benefit of 4 deaths averted for 10 000 women screened.

In these studies, the marginal improvement in terms of reduced mortality was only perceptible in women over 50 years of age. A much greater benefit in life-years gained would be achieved if screening mammography delayed death from breast cancer in younger women, but unfortunately this is not the case.29

Finally, the best preventive strategy does not necessarily include screening.30 Where an important risk factor (such as tobacco use, raised blood pressure or physical...
inactivity) can be reduced without selecting a high-risk group for preventive action, it is better to concentrate on available resources and use public policy and environmental measures to establish mass approaches to prevention.

**Study questions**

6.1 Describe the four levels of prevention. Give examples of action at each level which would be appropriate as part of a comprehensive programme to prevent stroke.

6.2 Which of the two approaches to primary prevention of diabetes and obesity outlined in Table 6.3 is preferable?

6.3 What characteristics of a disease would indicate its suitability for screening?

6.4 What epidemiological study designs can be used to evaluate a screening programme?

**References**


