Chapter 5

The neglected epidemics of noncommunicable diseases and injuries

The two preceding chapters have focused on disorders that are commonly associated with low-income countries, such as communicable diseases, poor reproductive health and malnutrition. We turn now to two entirely different challenges which, though less frequently associated with the developing world, are expected to transform its health needs over the next 25 years. They are the emerging epidemics of noncommunicable diseases—from psychiatric conditions to lung cancer—and of injuries. As populations age and become increasingly exposed to tobacco and other risk factors, these epidemics have advanced in countries such as China and Mexico and are already beginning in countries of sub-Saharan Africa. They could soon dominate governments' health care budgets, and yet they have been almost totally neglected by international health research. No country has prepared adequately for them, and time is short.

All countries' populations are aging, but the populations of the middle-income and low-income countries, following steep declines in their fertility, are aging more rapidly than those of the industrialized countries. In many middle-income countries and some low-income countries, the proportion of the population aged over 65 is expected to increase by 200% or more between 1990 and 2025 (Figure 5.1). Population aging results not only in a greater proportion of elderly people, but also—at earlier stages in the process—in increased proportions of adults of all age groups, including young adults, relative to children. This in turn increases the relative burden of noncommunicable diseases in the population. Projections for this Report indicate that the middle-income and low-income countries are likely to see steep increases in the number of cases of many noncommunicable diseases—such as psychiatric and neurological conditions, ischaemic heart disease, cerebrovascular disease and cancers—between now and the year 2020. The numbers of people with disabilities and impairments associated with age, including visual and hearing impairments, are also projected to increase. And, because young adults are at greater risk than other age groups for many forms of injury including road-traffic accidents, interpersonal violence and occupational injury, the importance of injury is likely to rise (Annex 1).

Since population aging is a major factor in increasing the burden of noncommunicable diseases, the prevention and cost-effective case management of noncommunicable diseases is a prerequisite for achieving healthy aging—a social goal shared by virtually all countries. The health sector's efforts to promote healthy aging must clearly go beyond the avoidance of disease and its consequences, but effective disease prevention and control are nevertheless inextricably linked with a good quality of life in older age.

Beyond the relatively predictable demographic shift now in progress worldwide, a second, inherently more complex, process is taking place. Populations' exposure to some risks associated with noncommunicable diseases has recently been growing rapidly. Increased tobacco use is the most obvious risk and one of the greatest threats to health worldwide: as the smoking epidemic takes hold in low-income countries, the burden of disease and death associated with it is expected to *treble* (Annex 2). Diets are also changing, with widespread increases in the amounts of saturated fat consumed by populations whose intake was traditionally lower. Patterns of physical activity are changing with increased urbanization and the spread of motorized transport. The prevalence of obesity is increasing more rapidly than most other risk factors, not only in the industrialized countries but also, for example, in China; and obesity is, of course, a risk factor for diabetes, hypertension, ischaemic heart disease and stroke.

While the demographic determinants of change in disease burden are comparatively simple to assess, the effects of changing exposure to risk are much more complex and more difficult to predict. Aging leads to an increase in the absolute number of cases of noncommunicable diseases, but does not in itself affect the *age-specific rates* of incidence of mortality from any of these conditions. Increased exposure to risk factors, by contrast, may affect age-specific rates of disease. In the case of tobacco, the experience and data from the industrialized countries are sufficiently robust to enable epidemiologists to predict massive increases in the rates of tobacco-related deaths worldwide as a direct consequence of increases in exposure. Yet for other risk factors, where past trends are much less clear, it is difficult to project the impact of changing exposure with such certainty (Annex 2). The demographic and epidemiological components of projected change in the burden of disease need to be clearly distinguished (Annex 1). It should be stressed, however, that the scale of the demographic change is expected to determine a large worldwide increase in the number of cases of noncommunicable diseases and injuries, and in their share of global disease burden, whatever the more complex impact of changes in exposure to risk.

If governments and health service providers are to respond adequately to this challenge they need information: first, about the size of the projected burden, and

second, about what they can do to reduce it. They cannot change the demographic trends, but they may be able to reduce the overall burden by reducing or even eliminating people's exposure to some risks, and by developing, evaluating and implementing cost-effective algorithms for case management of disease. In this chapter, we discuss the two epidemics of noncommunicable diseases and injuries in turn, assessing the current and projected burden and the burden attributable to selected risk factors. We then discuss research needs and intervention opportunities.

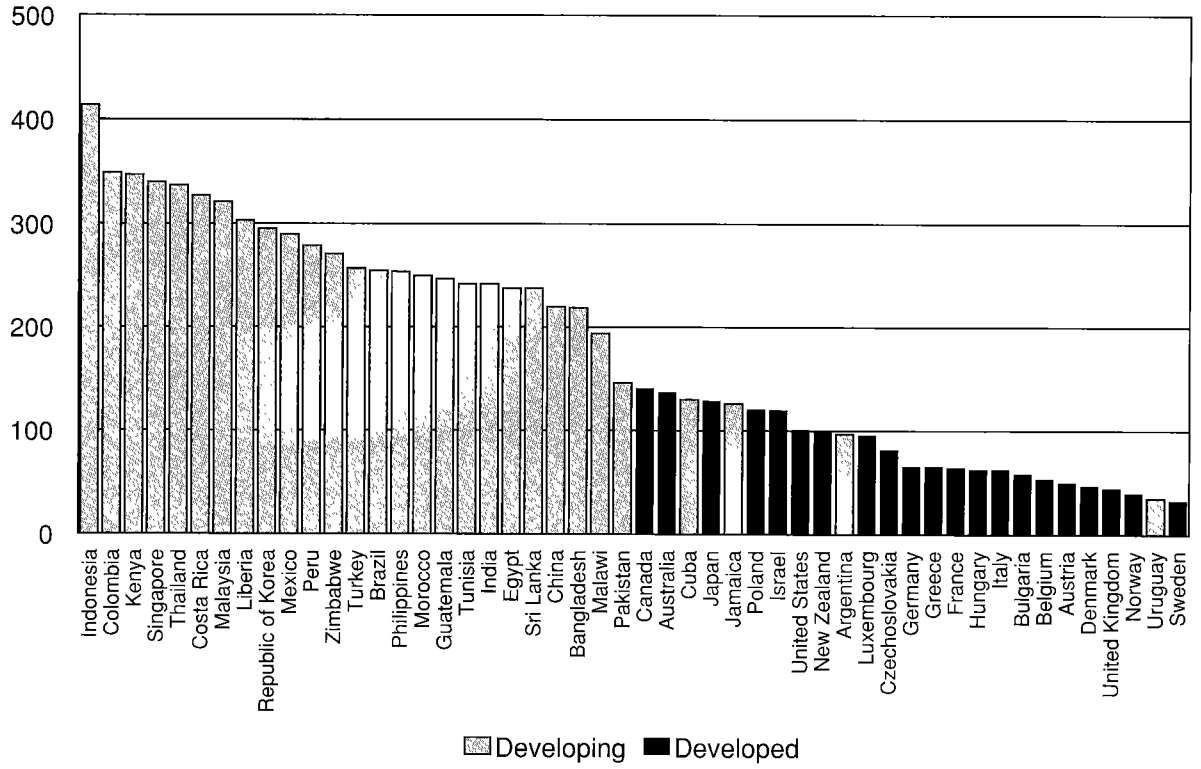
5.1. Noncommunicable diseases

5.1.1 The magnitude of the burden

In 1990, all noncommunicable diseases together accounted for about 41% of global disease burden—measured in lost years of healthy life, or DALYs—and 56% of deaths worldwide. Projections for this Report indicate that by 2020 they could account for almost 60% of disease burden and 73% of deaths (Annex 1, baseline projection). However, this global picture masks the regional unevenness of the change. In the established market economies, where noncommunicable diseases already account for more than eight out of ten lost years of healthy life, the increase in burden from these conditions will be negligible. By contrast, in low-income and middle-income countries the increase is expected to be sharp and steep (see figures 5.2, 5.3 and 5.4). In India, for example, the share of all disease burden due to noncommunicable diseases is projected to almost double over just three decades from about 29% to almost 57%; in China, the projected increase is from 58% to 79%; and in the developing regions of Asia excluding China and India, from 41% to 66% (Annex 1). During this period the health needs of these regions and nations will be unstable and complex, with some areas and groups seeing faster change than others; but the overall trend is likely to be similar everywhere.

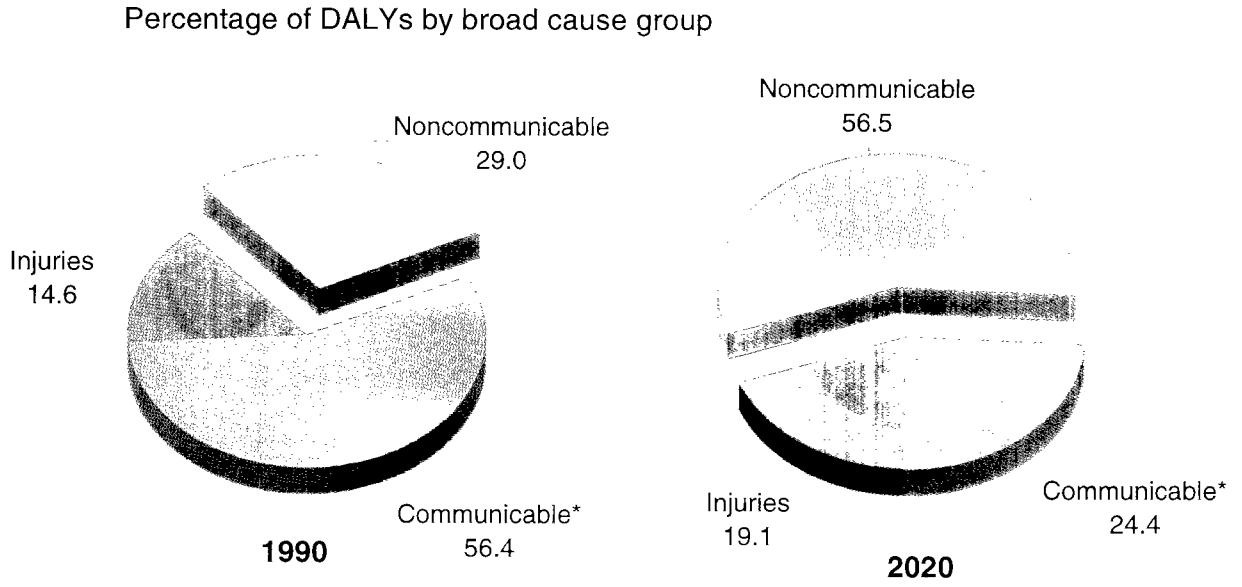
These broad trends, though striking, are not sufficiently detailed to be informative about future health needs. Here we discuss the four main disease clusters that together make up three-quarters of the total burden of noncommunicable diseases: psychiatric and neurolog-

Figure 5.1 Increase in population aged over 65, 1990–2025, percentage growth



Source: U.S. Bureau of the Census 1992:12

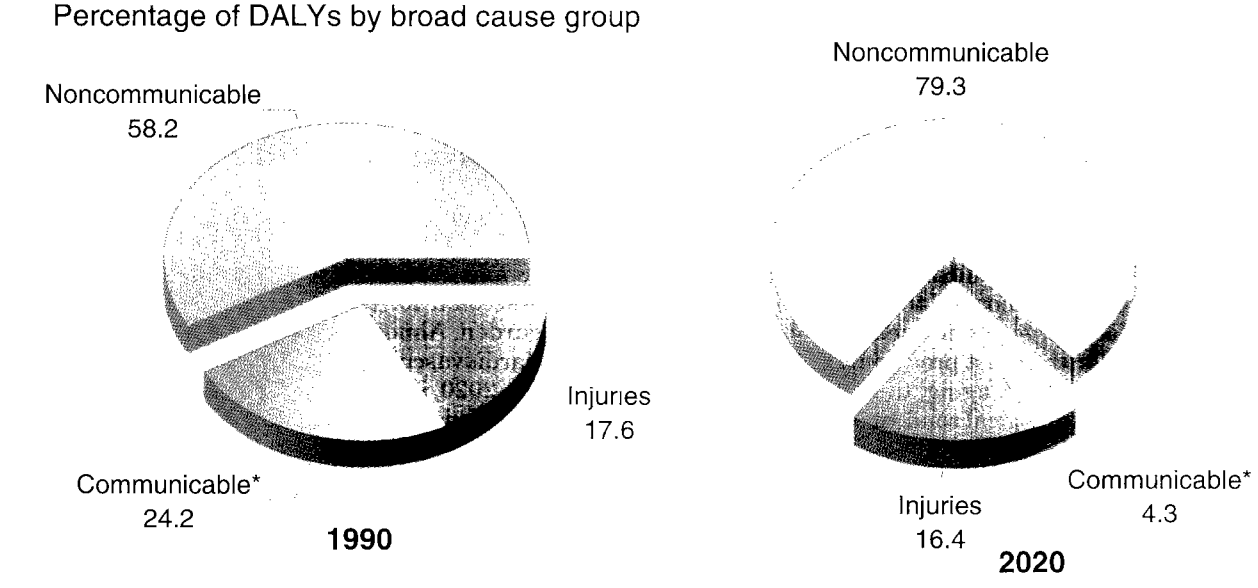
Figure 5.2 Distribution of disease burden in 1990 and projected for 2020, India



*Includes maternal and perinatal

Source: Annex 1, tables A1.9 and A1.10

Figure 5.3 Distribution of disease burden in 1990 and projected for 2020, China

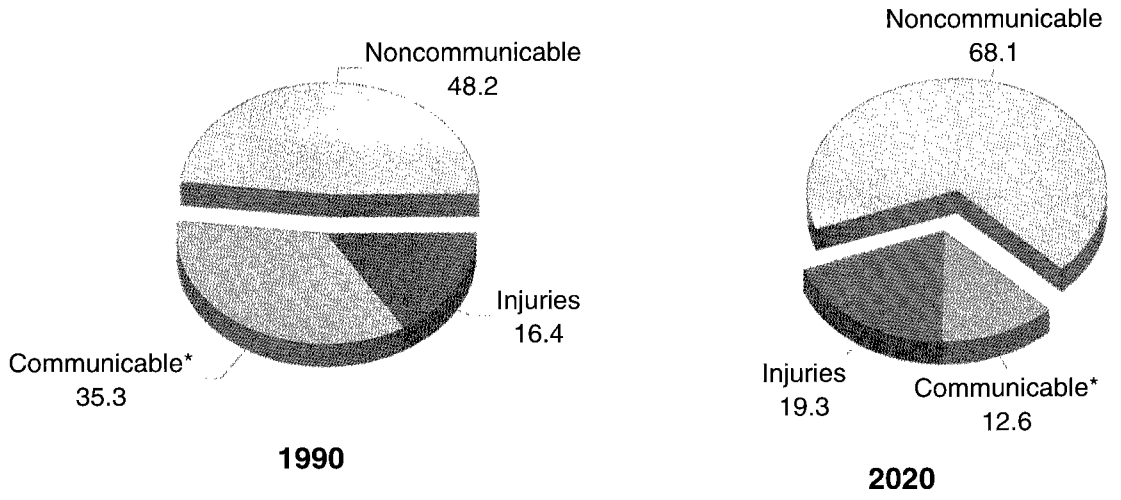


*Includes maternal and perinatal

Source: Annex 1, tables A1.9 and A1.10

Figure 5.4 Distribution of disease burden in 1990 and projected for 2020, Latin America and the Caribbean

Percentage of DALYs by broad cause group



*Includes maternal and perinatal

Source: Annex 1, tables A1.9 and A1.10

ical conditions; cardiovascular diseases and diabetes (which we discuss together for reasons explained below); cancers; and respiratory diseases. This section summarizes the current and future projected burden for these four disease clusters, together with an assessment of the current burden from several risk factors that predispose to them. The global change is summarized by Figure 5.5. For comparison, Figure 5.6 shows India, a large country projected to undergo particularly rapid change.

5.1.1.1 Major noncommunicable diseases

Psychiatric and neurological conditions are among the most neglected group of health problems worldwide. In 1990, they accounted for over 10% of total global disease burden—and a quarter of the noncommunicable disease burden. They are a diverse group and regional variations are significant, but seven important conditions account for most of the total (Table 5.1). Of these, depression—properly termed unipolar major depression—is by far the most prevalent.

Because of population aging, the future burden from psychiatric and neurological conditions is projected to be even greater, reaching almost 15% of total burden by 2020. By the third decade of the next century unipolar major depression is projected to become the *leading cause of disease burden in the developing regions, and the second most important cause of disease burden worldwide*. Worldwide it will closely follow ischaemic heart disease, the leading cause, accounting for 5.7% of total burden and overtaking stroke (Annex 1). For demographic reasons, the projected increase is relatively steeper in regions where these conditions are currently believed to be less widespread: in sub-Saharan Africa, for example, psychiatric and neurological conditions will rise from 4% of burden to more than 8%, in India they will climb from 7% to almost 13%, and in the Middle Eastern crescent from just under 9% to 15%. These projections, which are likely to come as a considerable surprise to many involved in health planning and policy, underscore the extent of underpreparation and ignorance about future health needs.

Cardiovascular diseases already account for almost 10% of total global burden. By 2020, fully 14.7% of global burden could be attributable to this group of conditions. The two principal conditions are ischaemic heart disease and cerebrovascular disease (stroke), which together account for two-thirds of the cardiovascular disease burden. Almost all of the projected increase in the total cardiovascular disease burden is attributable to them; by 2020, ischaemic heart disease is expected to become the leading cause of disease burden worldwide. Diabetes mellitus, a condition closely associated with cardiovascular disease, accounts for just under 1% of disease burden (Annex 1).

Cancers of all sites and types accounted for about 5% of total burden and about one-eighth of the noncommunicable disease burden in 1990. By 2020, they are ex-

Figure 5.5 Change in five types of noncommunicable disease, 1990–2020

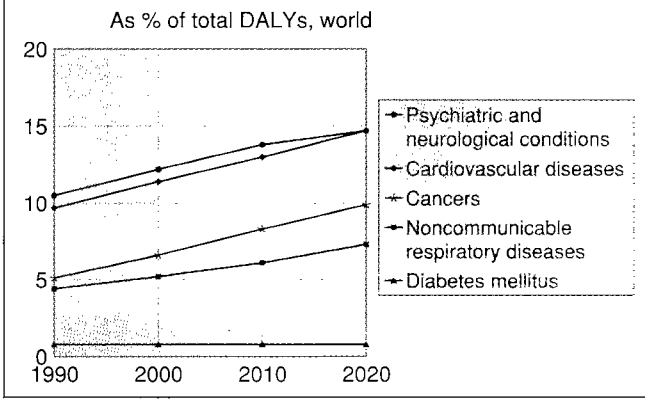
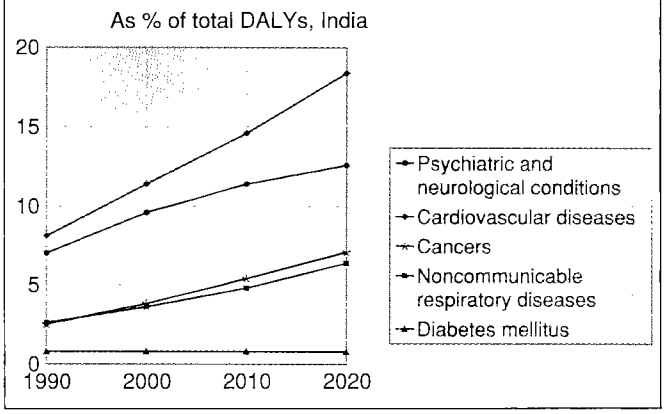


Figure 5.6 Change in five types of noncommunicable disease, 1990–2020



pected to double in importance to reach almost 10% of the total burden. Of all sites and types, the two most widespread categories in 1990 were cancers of the lung, bronchus and trachea, and stomach cancer, both at 0.6%. By 2020, however, the lung, bronchus and trachea group is expected to be a clearly greater problem at 1.8%, largely because of tobacco use, while stomach cancer is projected to advance to only 1.2% of global burden. Other important types of cancer include liver cancer, which is expected to rise from 0.5% of total burden to a projected 1.1% in 2020; leukaemia; and cancers of the breast and cervix. By 2020, cancers of the breast and cervix could together account for almost 1% of global disease burden.

Noncommunicable respiratory diseases claimed 4.4% of the total global burden in 1990, and are expected to claim more than 7% of burden by 2020. Of this group, chronic obstructive pulmonary disease is the most significant and could double its share from 2% to 4%. Asthma currently accounts for 0.8% of the total and is expected to climb slightly to 1% by 2020.

5.1.1.2 Risk factors for noncommunicable diseases

Risk factors are a broad grouping which includes behavioural risks (such as tobacco use), physiological risks (such as hypertension), and conditions which are themselves risk factors for other conditions (such as diabetes mellitus). Some, such as tobacco use or obesity, are modifiable; some, such as gender or family history, are not. Clearly, the development of health policy depends upon better and more accurate measures of the importance of different risk factors—especially those that are modifiable—in contributing to the burden of disease in a population. This Report has provided some initial estimates of the burden attributable to selected risk factors (Annex 2). Details of the methods used are explained in the companion volumes to the Report; key findings are summarized here.

Tobacco is a risk factor for some 25 diseases and, while its effects on health are well known, the sheer scale of its impact on global disease burden may still not be ful-

Table 5.1 The burden of psychiatric and neurological conditions, 1990, selected regions (%)

Condition	World	China	Latin America/ Caribbean	Middle Eastern crescent
All psychiatric and neurological conditions	10.5	14.2	15.9	8.7
Unipolar major depression	3.7	6.2	4.3	3.0
Bipolar affective disorder	1.0	1.8	1.2	0.9
Alcohol use	1.2	0.7	3.9	0.2
Schizophrenia	0.9	1.3	1.3	0.9
Dementia*	0.6	0.7	0.6	0.2
Drug use	0.4	0.1	1.1	0.6
Epilepsy	0.4	0.4	0.7	0.3
Other psychiatric and neurological conditions	2.2	2.9	2.8	2.5

*includes other degenerative and hereditary disorders of the central nervous system.

Note: Numbers in this table have been rounded to one decimal place. This leads to rounding errors that prevent the totals for individual conditions from exactly matching the group subtotal.

Source: Annex 1

Table 5.2 Avoidable burden of disease if tobacco use were eliminated, 1990 and 2020

	% of all DALYs attributable to tobacco use	
Region	**1990**	**2020**
Established market economies	11.7	17.0
Former socialist economies	12.5	19.9
India	0.6	10.2
China	3.9	16.1
Other Asia and islands	1.5	6.1
Sub-Saharan Africa	0.4	1.7
Latin America and Caribbean	1.4	6.8
Middle Eastern crescent	1.2	7.3
World	2.6	8.9
Established market economies and former socialist economies	12.1	18.2
Demographically developing countries	1.4	7.7

Source: Annex 2

ly appreciated. In 1990, tobacco killed about three million people. By 2020, it is expected to kill more than 8 million a year (Annex 2). No single *disease* is expected to make such a giant claim on health as this one *risk factor*. Estimates for this Report show that tobacco is already responsible for about 2.6% of the total disease burden, and that it is projected to treble its share to an astonishing 8.9% of the total in 2020 (Table 5.2). For each 1000 tonnes of tobacco produced, about 1000 people will eventually die.

The impact of tobacco on men's health is already fully felt in the industrialized world, although its effect on women has yet to reach its peak. In the low-income and middle-income countries the epidemic is only now beginning, but in terms of absolute numbers it is likely to dwarf anything experienced in the industrialized nations. The biggest and sharpest increases in disease burden are expected in India and China, where the use of tobacco has grown most steeply. In India, the burden attributable to tobacco is expected to climb *more than tenfold* from less than 1% in 1990 to 10% in 2020. In China, the burden may climb fourfold from about 4% to about 16%; some 50 million of the population now aged under 20 in China will eventually be killed by tobacco in middle or old age. In the Middle Eastern crescent, tobacco currently accounts for about 1% of all burden but may claim more than 7% by 2020. It is estimated that about half of all men and almost 10% of the women in low-income and middle-income countries are smokers; most start their habit as children or teenagers, and the numbers are still rising. Women and young people are increasingly targeted as growth markets for tobacco.

Alcohol is a second highly significant risk factor for disease: worldwide, some 3.5% of total disease burden in 1990 was attributed to it (Table 5.3).

Other risk factors. In addition to the two major risk factors of alcohol and tobacco, certain others are also significant, especially when considered by region. For example, 1.4% of the total global disease burden is attributable to hypertension, with the proportion rising to 5.9% in the former socialist economies. A further 1% of the total burden is attributable to physical inactivity. In the established market economies, physical inactivity accounts for about 4.8% of the total disease burden while in sub-Saharan Africa, perhaps unsurprisingly, its contribution is negligible. Air pollution is significant in the former socialist economies where it accounts for an esti-

Table 5.3 Avoidable burden of disease if alcohol misuse could be eliminated

	% of all deaths and DALYs attributable to alcohol, 1990	
Region	**Deaths**	**DALYs**
Established market economies	1.2	10.3
Former socialist economies	1.4	8.3
India	1.2	1.6
China	1.3	2.3
Other Asia and islands	1.8	2.8
Sub-Saharan Africa	2.1	2.6
Latin America and Caribbean	4.5	9.7
Middle Eastern crescent	0.1	0.4
World	1.5	3.5
Established market economies and former socialist economies	1.3	9.6
Demographically developing countries	1.6	2.7

Source: Annex 2

mated 3% of disease burden; worldwide, it accounts for about 0.5%.

Projections of the impact of these risk factors on disease burden in 2020 have not been performed because of the uncertainties that still surround the assessment of attributable risk (Annex 2). This is partly because the data on past trends are limited and, where they exist at all, they show mixed trends. For example, age-specific rates of cardiovascular diseases have been declining for two decades in the established market economies but rising in the former socialist economies. In São Paulo, age-specific rates for cardiovascular diseases are falling; in Mexico, age-specific rates for ischaemic heart disease are rising.

While assessments of the impact of specific risk factors on total disease burden for each region are highly useful, they provide only part of the picture. A more detailed assessment of the relative contributions of different risk factors to specific diseases is also needed to enable effective prevention strategies. The risk factors for cardiovascular diseases illustrate this well. Although different forms of cardiovascular disease share several common risk factors, their contributions vary in each (Table 5.4). For example, haemorrhagic stroke is much more closely linked with hypertension than atherothrombotic stroke. The relative importance of the different risk factors also differs within and between populations. Men are at greater risk for this group of diseases overall than women, but male sex is a much stronger risk factor for ischaemic heart disease than for stroke. There are also certain ethnic differences in predisposition which remain largely unexplained: for example, populations of African origin appear to be at increased risk of hypertension, diabetes and haemorrhagic stroke; North Europeans and Americans are more prone to atherothrombotic stroke. In South Asian populations, a syndrome including the accumulation of central fat, disturbed blood lipids and insulin resistance appears to be particularly common as a precursor to diabetes and coronary heart disease. The so-called "thrifty-gene" hypothesis invoked to explain this syndrome requires more research.

Risk factors may also predispose individuals to more than one disease. Thus, for example, the risk of both stroke and ischaemic heart disease rises steadily with elevation in blood pressure, while smoking increases the risk of both coronary heart disease and atherothrombotic stroke, as well as several cancers and chronic lung diseases. Obesity predisposes to diabetes, hypertension, ischaemic heart disease and stroke. Interventions that reduce exposure to one or more risk factors may therefore reduce the risk of several different cardiovascular diseases. By the same token, interventions may have to tackle more than one of these diseases to maximize their effect. In an environment of scarce resources, governments and health providers will benefit from knowing which risk reduction activities are likely to have the most cost-effective impact in reducing disease burden.

5.1.2 Current investment

The Committee has obtained estimates of spending for selected areas of research on noncommunicable diseases and their predisposing risk factors, using the "capture-recapture" methods described in Annex 5. The figures represent averages for the years 1992 to 1994. Epidemiological studies of cardiovascular disease with some relevance to low-income and middle-income countries received US$ 100 million. Asthma research was rather better funded relative to the disease's share of

Table 5.4 Association between known risk factors and cardiovascular diseases

Risk factor	Coronary heart disease	Athero-thrombotic stroke	Haemorrhagic stroke	Hypertensive heart disease
Non-modifiable				
Age	++++	++++	++++	++++
Male sex	++++	++++	++++	+
Black race	+	++	+++	+++
Family history	++++	++	++	++
Modifiable physiological				
Elevated LDL	++++	++	-	0
Decreased HDL	++++	+	0	0
Hypertension	+++	++	++++	++++
Diabetes	+++	+++	0	0
Obesity	++	+	?	++
Behavioural				
Smoking	++++	++	0	0
Dietary cholesterol and saturated fat	++	+	-	-
Salt intake	0	+	++	++
Alcohol intake	-	+	+	+
Sedentary lifestyle	++	?	0	+

Note: Degree of association between disease and risk factor ranges from + (weak) to ++++ (strong); 0 = no association; - = Inverse association; ? = unclear association.

Source: Pearson, Jamison & Trejo-Gutierrez 1993, with minor modification

global burden, receiving between US$ 127 million and US$ 158 million—or about US$ 13 for every DALY. The total R&D investment into tobacco use, meanwhile, was estimated at between US$ 148 and US$ 168 million—or a mere US$ 4.40 for each DALY. These three figures, though giving only the most partial picture of funding for noncommunicable disease research overall, are an indication of the nonrational basis of current investment. While, once again, there is no suggestion that funding for R&D into specific conditions should be directly proportionate to disease burden, there is little doubt that better information on the ratio of investment to current or future burden could prove a highly provocative adjunct to other information when assessing resource allocation.

In addition, we have obtained estimates of the investment by major sources in the established market economies into R&D on noncommunicable diseases in low-income and middle-income countries. Even allowing for the fact that not all sources have been able to provide complete information, the total is unlikely to exceed US$ 35 million; this represents less than 5% of the total health R&D support from these investors and only a tiny fraction of the total spent on R&D into noncommunicable diseases in the established market economies (Annex 5). A small minority of investors, notably Canada's International Development Research Centre (IDRC) and the United Kingdom's Overseas Development Administration, have initiated support for research in noncommunicable diseases in developing countries, but the scale of their investment is small, so the overall picture is one of neglect. Spending by the middle-income countries on R&D into noncommunicable diseases could not be assessed, but it is expected to be relatively low.

5.1.3 Assessing research needs

It is beyond the Committee's scope to discuss research needs in detail for all noncommunicable diseases and this Report is intended as a stimulus to further debate by others with relevant expertise in each area. However, the current gaps between need and R&D activity appear to be so great that some general priorities can be readily identified.

As in previous chapters, the Committee's assessment of research needs is structured by an analysis of the reasons for the persistence of the burden from each condition as a guide to identifying the types of R&D effort that are most needed. As set out in Chapter 1, those reasons are grouped broadly as (a) lack of knowledge of the disease and its determinants, (b) lack of tools to prevent or treat it, and (c) failure to use existing tools efficiently. Thus, for example, if the main reason for the persistence of a condition or disease is judged to be (a), lack of knowledge about the disease or its determinants, then strategic research in one or more disciplines may be needed to build the knowledge base before a broad range of new interventions can be developed. If the main reason is judged to be (b), a lack of tools, then development efforts to increase the range of available interventions is a priority; and so on. Often, of course, more than one reason will be judged to contribute and then parallel R&D activities may appear to be appropriate. Unlike chapters 3 and 4, this chapter contains no quantitative analyses of the relative shares of disease burden attributable to each. Ongoing efforts will be required to develop these analyses further.

Neurological and psychiatric conditions. While neuroscience is, as Chapter 2 showed, one of the fastest growing areas of current biomedical research, mental illness nevertheless remains one of the most neglected areas of need. In stark contrast to the scale of the disease burden and the economic losses attributable to mental illnesses, investment in R&D into depression, bipolar disorder and schizophrenia has remained relatively low in all countries, whatever their income level. Some neurological diseases with potential markets for pharmaceuticals companies and effective lobby groups in the established market economies—notably Alzheimer disease and Parkinson disease—have recently seen some expansion of R&D effort. Yet these diseases, however distressing, account for a relatively small part of the total global burden, and are dwarfed by the more common conditions such as unipolar major depression, bipolar disorder and schizophrenia.

The few studies that exist from primary health care facilities in low-income and middle-income countries suggest that in many patients mental disorders go undetected and therefore untreated even though specific and acceptable treatments exist. The studies also report a relatively low concordance between the health worker's recognition of a specific psychological disorder and the research diagnosis of a definite psychological disorder as defined by ICD-10 (Üstün & Sartorius 1995). These findings suggest that health workers' awareness and knowledge of mental disorders is inadequate, their ignorance probably reflecting a broader overall ignorance within the health sector. Within the Committee's scheme of three broad reasons for explaining persisting disease burden, therefore, the first (a) and third (c) appear to be most significant: a lack of knowledge of the basic epidemiology of these diseases has allowed them to remain hidden, while failure to use the existing tools properly has left many people unnecessarily without help.

While the important conclusions of the studies in primary health care facilities have been consistently replicated across centres and regions, their authors also report significant variation in the prevalence of common disorders across centres, even though all methodological precautions were taken to standardize measurement. The reasons given for this variation have included: differences in the health beliefs and care-seeking behaviour of people attending general health care services; differences between centres in the style of delivering care; differences in the facilities selected for participation in the studies; and cross-cultural differences in response patterns to diagnostic questions. There is also evidence of a wide range of treatment strategies. These findings

suggest that cultural and local variations continue to complicate the study of psychological disorders. In addition, an unknown but presumably large number of people with psychiatric disorders seek help from traditional healers and little is known about the efficacy of the various treatments and therapies they receive.

Tobacco. Tobacco is fast becoming a greater cause of death and disability than any single *disease* and few in the health sector would challenge demands for widespread, intensified action to reduce its impact. However, the health sector's efforts to reduce tobacco use have been severely diluted by the powerful alliance of the tobacco companies and agricultural interests. Much of the existing burden from smoking—and its expected trebling in the near future—may be attributed to governments' inadequate commitment to controlling the production and marketing of tobacco using existing, effective strategies such as taxation and advertising bans. This is reason (c), failure to use existing tools efficiently.

However, it is possible that some governments lack the incentive to control tobacco use because they have not been persuaded of its devastating impact, either on health or development, in their own economies. A key factor in convincing governments of the need for better controls may be better data—both of the epidemiology of tobacco use in their own regions and of its impact on development. Therefore (a), a lack of knowledge, may still be a problem. Some further epidemiological research is clearly needed to provide all countries with reliable estimates. Further investigation of low-cost schemes for reliable data collection are a priority.

Indeed, the requirement for further epidemiological information extends beyond national needs to global ones. While the impact of tobacco on mortality is already well studied in the established market economies, some important questions remain unanswered in other populations. Little is known, for example, about the possible interaction of smoking and high-fat diets in the pathogenesis of ischaemic heart disease in low-income countries; about the possible interaction between tobacco and occupational and outdoor air pollutants in contributing to respiratory diseases; or about the importance of indoor tobacco smoke as a risk factor for the already high burden of childhood respiratory diseases in low-income countries. Such is the scale of the disease burden attributable to tobacco that even apparently minor epidemiological differences between populations could become highly significant for the assessment of future health need and the targeting of risk reduction activities. Equally important, there are large gaps in the knowledge base about the behavioural incentives and disincentives for tobacco use by men and women in low-income countries where an adverse impact on health has not yet been felt. Finally, even those countries that have implemented policy controls on tobacco have rarely evaluated their impact in full or on a continuing basis. Therefore, we conclude, (a) a lack of knowledge—both in epidemiology and in behavioural research—contributes significantly to the continuing tobacco epidemic.

Cardiovascular disease and diabetes are grouped together for this discussion because they share certain risk factors. Within the cluster of all cardiovascular diseases, we focus on:

- ischaemic heart disease; and
- stroke (cerebrovascular disease).

Together, ischaemic heart disease and stroke account for almost two-thirds of the total burden of cardiovascular disease worldwide. Other types of cardiovascular disease, including rheumatic heart disease, are shown in Table A1.9 (Annex 1), but have been excluded from this discussion because of their different aetiology and their relatively smaller current and projected burden.

- Diabetes mellitus in its most common form, non-insulin-dependent diabetes, not only shares certain risk factors with cardiovascular disease, such as obesity, but is itself also a risk factor for some forms of cardiovascular disease. Therefore, from a more practical point of view, it is worth discussing diabetes together with cardiovascular disease because both may respond to similar primary prevention strategies.

It should be noted that the relative contribution in different populations of each of the risk factors discussed above remains unclear. In the Committee's scheme for explaining the persistence of disease burden in three broad groups of reasons, a lack of knowledge of the determinants of these diseases—reason (a)—may be important because it is hampering the design of prevention strategies. In particular, the determinants of obesity are relatively underresearched, and there have been few studies of strategies for reducing obesity in populations.

However, prevention is not enough; treatments are also required. The physiology of cardiovascular disease has been extensively studied and therapies exist for hypertension, angina, hypercholesterolaemia and diabetes mellitus; the prospects for much more effective treatment of strokes are also good. Some effective therapies for aspects of cardiovascular disease, such as aspirin and diuretics, are also low in cost. However, in low-income and middle-income countries, there has so far been little investment to develop and evaluate algorithms that combine the available low-cost effective interventions to greatest advantage. Therefore a lack of tools—reason (b)—must explain a significant part of the burden.

Finally, and to a lesser extent, (c)—failure to use existing tools efficiently—may also play a part. The best existing treatments are not reaching all who need them: surveys of physicians' behaviour have revealed tremendous variation between and within regions and nations in the types of treatment given, for example for stroke, with some treatments of unproven efficacy being widely used.

Cancers are a heterogeneous group and this discussion will limit itself to a few major cancers. Since a considerable proportion of the total cancer burden is attributable to tobacco, R&D priorities for *preventing* cancer must be dominated by the same research agenda as for tobacco. Of the remaining burden of cancers, a considerable proportion are infectious in origin. In the developing world, cervical cancer, which is strongly associated with the human papilloma virus, is the leading cause of cancer mortality in women and the third most common cancer. Liver cancer, strongly associated with hepatitis B virus, is another important form of the disease. The persistence of these cancers may be attributed in part to (b), lack of tools, such as a vaccine against human papilloma virus, and in part to (c), failure to use the existing tools, such as cervical screening, or the existing hepatitis B vaccine, efficiently.

However, the proportion of all cancers that cannot currently be prevented with existing interventions is greater than the preventable portion, and therefore R&D must also be concerned with improving *treatment* and *palliation*. At present, about 90% of the scarce health care resources available for cancer in low-income countries are being absorbed by therapies of marginal effectiveness, because diagnosis occurs too late. Meanwhile palliative therapy, which can be highly cost-effective, fails to reach many of those who need it. In the Committee's view, the principal reasons for the persistence of disease burden from many cancers are (b), a lack of tools, such as cost-effective, locally appropriate algorithms for early diagnosis, and (c) failure to use existing tools, such as pain relief, effectively.

Respiratory diseases, like cancers, are substantially dominated by the impact of smoking and once again, R&D to reduce their burden should be a part of the tobacco research agenda. In addition, however, the impact of air pollution in domestic and industrial settings may require further evaluation.

Table 5.5 summarizes the discussion above.

5.1.4 Priorities for strategic research

From the discussion above, the Committee concludes that the two overriding priorities for strategic research to respond to noncommunicable diseases are for:

- Epidemiological studies to collect, in a cost-effective manner, data on incidence, prevalence and trends of death, disease and disability by cause; and quantification of the associations between important noncommunicable diseases and their known risk factors, in low-income and middle-income countries. *Basic* mortality and morbidity data in many populations are so poor that this knowledge is not currently available and trends cannot therefore be monitored. Data may be improved through:
  - (i) quantitative and qualitative improvements in death certification procedures, including the use of autopsy in sudden death;
  - (ii) validation and application of a "verbal autopsy" instrument for cause-specific ascertainment of cause of death;
  - (iii) cost-effective sentinel surveillance methods such as the system of disease surveillance points used in China;
  - (iv) estimates of the levels of disability and social costs linked with particular conditions and risk factors.
- Intensive health policy research to identify the options for ensuring effective disease prevention and equitable access to effective health care in a rapidly changing epidemiological situation. In particular, researchers should assess the relative benefits of emphasizing either "population-based" strategies, such as the introduction of incentives to change diets and reduce the risk of cardiovascular diseases, or more targeted strategies aimed at identifying those at high risk and treating them appropriately.

In addition to these two key requirements, further priorities for strategic research relevant to particular conditions are identified below:

- For psychiatric and neurological conditions, an epidemiology of needs, rather than disorders, must be developed, to enable the development of practical interventions. Thus, for example, it will be helpful to identify not how many people in a given population suffer from dementia, but how many are unable to feed themselves, how many require help with dressing, how many are at risk of burns or falls, and so on. Likewise, methodologies must be developed to enable

Table 5.5 Broad reasons for the persistence of noncommunicable diseases

Condition or risk factor	Inadequate knowledge of disease process and causes	Inadequate tools	Failure to use existing tools efficiently
Psychiatric and neurological conditions	+++	+	++
Disease attributable to tobacco use	++	+	+++
Cancers	++	++	++
Respiratory diseases	++	++	++
Cardiovascular diseases	+++	+	++

Note: The estimated rating ranges from + (weak) to ++++ (strong).

the trials of new interventions to be assessed in terms of practical outcomes.

- For tobacco control, health policy researchers must work with epidemiologists to assess the impact of tobacco both on health and on development in selected regions, and to identify approaches to intersectoral collaboration to limit the power of tobacco companies.
- Also for tobacco control, epidemiologists must assess the interaction of tobacco use with other risk factors in different populations, in order to gain the most accurate estimates possible of the likely future burden in those regions.
- For cardiovascular disease, better knowledge of risk factors and disease burden must be gained, for example, through:

  (i) case-control studies of incident acute myocardial infarction and stroke, to evaluate causal associations and intrapopulation risk ratios at various levels in the continuum of risk factor distribution. This provides an opportunity to evaluate putative risk factors that are of particular interest in specific populations. The work could build on ongoing efforts, for example in China, to assess the relative importance of different risk factors by case-control interview-based studies.

  (ii) behavioural research to identify determinants of smoking uptake, incentives to quit, etc., in different age groups and socioeconomic groups in low-income countries, with particular regard to studies of price elasticity in low-income groups.

While case-control studies are methodologically weaker than cohort studies or trials, they would permit researchers to gather information relevant to policy formation in a short time frame and at affordable costs.

5.1.5 Key opportunities for intervention development and evaluation

While strategic research is essential to build up the knowledge base, the urgency of the epidemic also requires shorter-term action. There is adequate knowledge now to assess the opportunities for some interventions. A few of the existing interventions are known to be cost-effective: primary prevention programmes, such as tobacco or alcohol control, can cost as little as US$ 35–55 per DALY averted. Chemotherapeutic treatments for some psychiatric conditions can be delivered for around US$ 100 per DALY averted, making them attractive to even the poorest countries. Aspirin has been estimated to be capable of saving about 100 000 lives after heart attack or thrombotic stroke, and preventing more than 100 000 further nonfatal heart attacks and strokes (Anti-Platelet Trialists' Collaboration 1994). Cost is unlikely to be a deterrent: in India, for example, aspirin may be provided for the treatment of acute heart attack for less than US$ 5 per case.

Most existing treatments for most noncommunicable diseases have nevertheless been developed with the needs of the established market economies in mind, and are far beyond the reach of most countries. In the United States, for example, the cost-effectiveness of treating patients with acute myocardial infarction (heart attack) using tissue plasminogen activator was recently calculated at well above US$ 30 000 per year of life saved (Mark et al. 1995). Affordable alternatives are obviously an immediate priority.

The Committee's assessment of desirable interventions for noncommunicable diseases has been made without the benefit of complete information. There is a shortage of good data on the cost-effectiveness of many treatment interventions for noncommunicable diseases that are relevant to low-income and middle-income settings. In addition, we have found that assessments of the likely required effort, costs and time frames for developing such interventions are more difficult than in areas where the knowledge base is already excellent. We consider that further ongoing work will be needed to improve quantitative information in this area. Meanwhile, the ongoing epidemic requires a range of responses in a very short time frame, so we have identified some interventions that are likely to reduce disease burden in low-income and middle-income countries in a cost-effective manner. These are listed below.

For psychiatric and neurological diseases:

- Develop methods, guidelines and training packs for increasing awareness of psychiatric conditions for primary health care workers.
- Consider expanding certain existing packages of health services for adults to include assessment for, and treatment of, psychiatric disorders.

For tobacco-related diseases:

- Develop policy instruments for tobacco control.

Because of the predominance of tobacco use as a risk factor, health policy researchers must rapidly develop, implement and evaluate programmes for tobacco control now, even while research into more effective intersectoral collaboration continues. Possible policy instruments range from agricultural crop substitution to legal, fiscal and advertising controls, and may also incorporate locally relevant, cost-effective anti-tobacco campaigns particularly for adolescents. Although there is evidence already from some low-income countries that price increases reduce demand (Stanley 1993), more evaluation research is needed to assess price elasticity in the lowest income groups.

For cardiovascular disease and diabetes:

- Evaluate low-cost interventions for preventing, diagnosing and treating cardiovascular disease.

Practicable, low-cost interventions should be evalu-

ated for efficacy and cost-effectiveness in low-income and middle-income countries, for example:

(i) population-based salt reduction in areas where food is traditionally heavily salted and hypertension and stroke highly prevalent (such as north-east China);
(ii) secondary prevention of stroke and acute myocardial infarction (e.g. with aspirin or low-cost diuretics) in individuals who have already experienced and survived a first event or are otherwise known to be at high risk;
(iii) management of angina;
(iv) simple regular assessment of lower limb sensation in individuals with diabetes and provision of protective equipment and advice to those at risk of foot ulcers.

For cancers:

In addition to the R&D agenda on tobacco:

- Complete research, development and trials of candidate human papilloma virus vaccines.
- Develop cost-effective diagnostic and treatment algorithms for selected major cancers.

For noncommunicable diseases in general:

- Develop and evaluate multisectoral population-based interventions to reduce multiple risk factors, for example, transport policies that encourage physical activity and may simultaneously reduce air pollution and road-traffic injuries.
- Develop policy instruments for reducing the diet related contribution to noncommunicable disease burden.

  Interventions are needed to address the rapidly growing burden of obesity worldwide. For example, evaluation research is required to assess the impact of pricing policies that encourage greater consumption of vegetables, fruit and fish and lower consumption of saturated fats and refined carbohydrates.
- Perform an audit of technology utilization and variation in practitioner behaviour to maximize cost-effectiveness and equity.

The growing burden of noncommunicable disease in a scenario of scarce health care resources makes it essential to ensure that resources are appropriately and safely used. Widespread variation between practitioners in the treatment of common conditions such as stroke has already been identified in some countries; in addition, traditional therapies of unknown efficacy are widely used (Box 5.1). The audit should be followed with pilot studies of training programmes and incentive structures that enable health workers to use the best practices, based on evidence of efficacy and cost-effectiveness, and successful training programmes or incentive structures should be disseminated for international use.

5.1.6 Aging as a development issue: the challenge to health systems

So far in this chapter we have restricted our discussion to the assessment of research needs for specific noncommunicable diseases and disease clusters. However, population aging presents all countries with a set of broader economic, societal and ethical challenges that will require new responses from researchers. Aging has been almost entirely neglected as a development issue, and health research has devoted relatively little attention to the problems that low-income and middle-income countries are likely to encounter.

In many countries, the "oldest old"—those aged 80 years or more, who are most likely to need support—are the fastest growing group, already constituting 16% of the world's total elderly population in 1992. In the United States, for example, the absolute number of over-80s is expected to more than double by 2030 from its 1990 level of 7 million (U.S. Bureau of the Census 1992). These changes will impose new and profound demands on all countries' health systems, whatever their income level, if they are to find affordable and equitable ways of meeting the competing needs of all age groups and balancing the rights of the individual with the greater good.

Healthy, active and independent old age is a goal increasingly attained by people in the established market economies; elders contribute much to society, and forward-thinking businesses are increasingly realizing the value of employing older people in flexible working patterns. There is growing evidence, too, that the "health span" as well as the life span may be lengthened by good nutrition, exercise and mental stimulation. However, for the developing economies, rapid population aging presents severe challenges. The world's "older" countries—in Europe, North America and Japan—are already deeply troubled by the costs of providing health care for the increasingly frail "older old", the costs of providing for a growing elderly population in economies whose active workforces are shrinking, and other questions of intergenerational equity. How much more acute, then, will these problems be for countries experiencing the transition in the space of barely two generations?

The especially rapid aging that middle-income countries, and some low-income countries, are experiencing today is quite unlike the slower process seen in the established market economies where economic growth has occurred in tandem with aging. While projections for this Report indicate that income is expected to increase steeply in the established market economies, income growth in other regions is expected to be slower, and in some regions, notably India and sub-Saharan Africa, the growth will be minimal (Annex 1). The widening gaps in GDP per capita between the richest and poorest regions will only intensify the problems faced by countries required to provide care for dependent elders while also suffering heavy burdens of disease in children and younger adults.

This problem is clearly illustrated by the case of Brazil. The country has experienced rapid demographic

transition—with fertility declining by about two-thirds in just 15 years. A report for the World Bank in the late 1980s concluded that by the middle of that decade, the 9% of the Brazilian population aged 55 and over were absorbing 44% of the social benefits provided by the government, mostly in the form of pensions and health care. Not surprisingly, the distribution of benefits was also skewed towards the richest in the population, with only one-fifth of the benefits reaching the 41% of households whose income was below half the level of the minimum wage (Brazil Department 1989). With further rapid aging of the population ahead, realistic and affordable policies for the care of older people are a priority.

Since the burden of childhood diseases may continue for some time while the adult disease burden climbs, the low-income and middle-income countries are likely to be faced for many decades to come with competing health needs, while rapid social changes such as the growing participation of women in the labour market reduce the availability of traditional, domestic unpaid care for the dependent elderly. While the educated and more affluent members of the populations of these countries will feel entitled to the same high-technology, cost-ineffective treatments for noncommunicable diseases that the established market economies have favoured, these cannot be delivered equitably. The pressure to meet all needs will pose formidable ethical and economic challenges to even the richest countries.

Indeed, it is possible that the health consequences of aging may be accelerated and intensified in low-income

Box 5.1 Traditional medicine: the need for research on efficacy and safety

Traditional medicine has been practised for as long as 5 000 years in Asia and is widespread worldwide. The World Health Organization estimates that up to 80% of people in developing countries use traditional health care systems as their main source of care. In practice, many may have little choice: in sub-Saharan Africa on average, there is only one Western-style physician for every 18 000 people, compared with one for every 2 400 in the established market economies.

Recent trends may even be increasing the reliance on traditional healers. In some African countries, devaluation resulting from structural adjustment policies has reportedly prompted a marked recent increase in household expenditure on traditional medicines, matched by a drop in quantities purchased of modern medicines. Similar trends have been reported from Pakistan. Established traditional healers in some countries have claimed that opportunists are exploiting this growing demand with overpriced "therapies" of dubious benefit. For all these reasons, the formal health sector is increasingly recognizing that:

- traditional healers are a significant force in local health care; and
- research and evaluation are required to ensure that the clients of traditional healers receive the maximum benefits and minimal risks from contact with them.

A number of forms of traditional therapy (Chinese traditional acupuncture for a number of important noncommunicable diseases, and some Chinese herbal medicines such as astralagus in HIV disease and *xinghaosu* in malaria) have been demonstrated to be effective in rigorous studies and it is likely that many more that have not yet been tested rigorously will also have health benefits. However, some techniques and herbs are unsafe. The United States Food and Drug Administration has found toxic substances in the herbs used in some concoctions available in the United States; data on toxicity and adverse effects in low-income countries are scarce. Possible toxic ingredients of some herbal medicines include mercury, arsenic and camphor. Furthermore, practitioners prescribe substances that may be harmful rather than helpful in treating illnesses. For example, *dong gui* is prescribed to women as a postpartum strengthener, yet it actually causes bleeding. The lack of regulation of traditional practices has resulted in the use of untested herbs and therapies that may at best be ineffective and waste scarce household resources, and at worst dangerous.

In order to make the best use of safe and potentially cost-effective therapies, and to guard against the risks of danger or waste, better data are needed. Most of the published literature on Chinese traditional medicine and Indian Ayurveda is not accessible to the international research community because it remains untranslated, and some existing studies are flawed by confounding factors and problematic experimental design.

Five areas need further investigation:

- translation of available studies into a range of other widely spoken languages to increase access;
- rigorous intervention trials to test the efficacy of herbal medicines and various other traditional practices;
- evaluation studies to identify ways to integrate appropriate traditional interventions into health system finance and service delivery;
- behavioural research to establish the reasons for the high satisfaction reported by users of traditional/complementary therapies;
- further evaluation studies to assess the feasibility of persuading traditional healers to carry modern medicines as well as traditional therapies, thereby increasing access to modern therapies. This approach is already being pursued, for example, in Mali, where some traditional healers now carry antimalarials.

and middle-income countries. Poverty, dietary and environmental stresses and infection may cause the impact of aging to be felt earlier, in the fourth and fifth decades of life. Factors such as poor nutrition in early life have, as we have discussed in Chapter 3, been shown to influence the development of disease in late maturity. In this respect, the diseases that were once linked with "affluence" have finally been recognized as diseases of poverty. In Canada, for example, mortality rates from stroke in people aged between 65 and 74 are far exceeded by the rates in Latin Americans a decade younger (Kalache & Aboderin 1995).

Many of the conditions associated with aging cause chronic illnesses for which there are currently few cost-effective interventions. For example, treatments for various cancers cost, on average, more than US$ 1000 for every DALY averted; the costs of case management for cerebrovascular disease are unknown but estimated to be high. Already in the industrialized countries, certain age-related diseases, impairments and injuries contribute significantly to disease burden. In the United Kingdom, for example, there are an estimated 50 000 fractures of the proximal femur (hip) every year; the incidence of these fractures rises steeply with age, particularly after age 80; the vast majority of those affected are elderly women and osteoporosis is a significant risk factor. A quarter of those affected die within six months; two-thirds of survivors have persistent pain and swelling; only a minority return to their previous level of functioning (J. Grimley Evans 1996). If the support services available to people with this condition in the United Kingdom were available worldwide, the extrapolated service cost burden for middle-income countries over the coming decades would be daunting.

Responding to population aging in a context of rapid social change will require innovative research. Behavioural scientists and epidemiologists will need to establish the key areas of possible intergenerational conflict; economists and health policy scientists will need to model the likely impact of a range of different measures to maintain equity of access to health care. This will require collaboration between the health sector and others—a subject to which we turn in the next chapter.

5.2 The accelerating epidemic of injuries

Partly because of the changing age structure of the population but also because of socioeconomic trends, the end of the 20th century is witness to an extraordinary rise in the burden of death and disability from injuries. Health researchers have devoted scarcely any attention or resources to these problems. Yet projections generated for this Report suggest that *the burden due to injuries could equal that due to communicable diseases worldwide by 2020. In several developing regions including China, and Latin America and the Caribbean, injuries are expected to exceed communicable diseases.* Today, injuries account for about one in every seven years of healthy life lost (DALYs) worldwide. By 2020 they are likely to account for *one in every five.* Low-income and middle-income countries will once again bear the brunt of the increase (Annex 1).

In this discussion we shall note the different kinds of injury and briefly set out what is known about their trends and determinants, before discussing priorities for future research directions.

While all projections contain uncertainties, the projected trends in injuries must obviously be viewed with particular caution. The study of injury and violence is comparatively new to the health research field and more information is needed about the links between various types of injury and socioeconomic trends before more confident projections can be made. Nevertheless, the Committee considers that this emerging group of problems requires immediate attention.

Injuries are a heterogeneous group, which partly explains their low profile as a public health issue. But their impact on communities and economies is profound. Because they tend to be concentrated in people between the ages of 1 and 45 and can result in long-term disability, they tend to affect productivity severely, particularly among the lowest income groups whose exposure to risk is greatest and whose earning capacity is most likely to rely on physical activity. Beyond these economic considerations, the impact of injuries on people's long-term psychological status is only now beginning to be realized.

Injuries can be categorized either by their outcome, such as laceration, burns, or anoxic injury, or by their external cause, such as homicide or road-traffic accidents. Here, we shall describe injuries by their external causes because it is the causes, not the consequences, that are likely to be most significant in determining preventive strategies.

There are two broad categories of injury:

- *unintentional* injuries, such as those caused by road-traffic accidents, fires, falls, drowning and occupational injuries; and
- *intentional* injuries, such as suicide, homicide and other violence such as rape, battering, child abuse, and war-related violence.

From the perspective of health researchers, injuries can be viewed as preventable at two different levels. First, action can be taken to reduce the likelihood of injury in the first place. Second, action can be taken to reduce the severity of an injury (for example, seat-belts reduce the risk of death in car crashes). Where prevention has failed, the consequences of injury can be treated by case management. While most research interest has focused on preventing injuries, there is no doubt that their effective treatment will be an important priority too.

5.2.1 The magnitude of the burden: trends in injury levels

Table 5.6 summarizes the distribution of burden from different categories of injury for 1990 and the pro-

jected burden for 2020 in order to highlight those types of injury that appear to be increasing in importance. A fuller picture can be found in Annex 1. The recent, strong secular upward trend in *intentional* injuries is expected to continue and will account for most of the overall projected increase. Among unintentional injuries, road-traffic accidents are the sole category projected to rise (see Figure 5.7).

5.2.1.1 Unintentional injuries

Road-traffic accidents are the most important cause of unintentional injury and constitute a major health problem worldwide: in 1990 they accounted for almost as much loss of healthy life as tuberculosis and ranked ninth among all causes of disease and injury burden. Over the next 25 years the burden due to road-traffic accidents is expected to rise sharply, due mainly to demographic change but also, to a lesser extent, to increased rates of accidents. By 2020, they are projected to be the third biggest cause of DALYs worldwide (Annex 1).

In low-income and middle-income countries, particularly those whose road networks and car ownership are expanding rapidly, rates of road-traffic accidents have been climbing steeply over recent decades. Those at greatest risk are not necessarily the car drivers: in the mixed traffic typical of crowded cities in low-income countries pedestrians, cyclists, rickshaw and cart drivers are more likely to be killed or seriously injured. Alco-

Table 5.6 The growing burdens of violence and car crashes

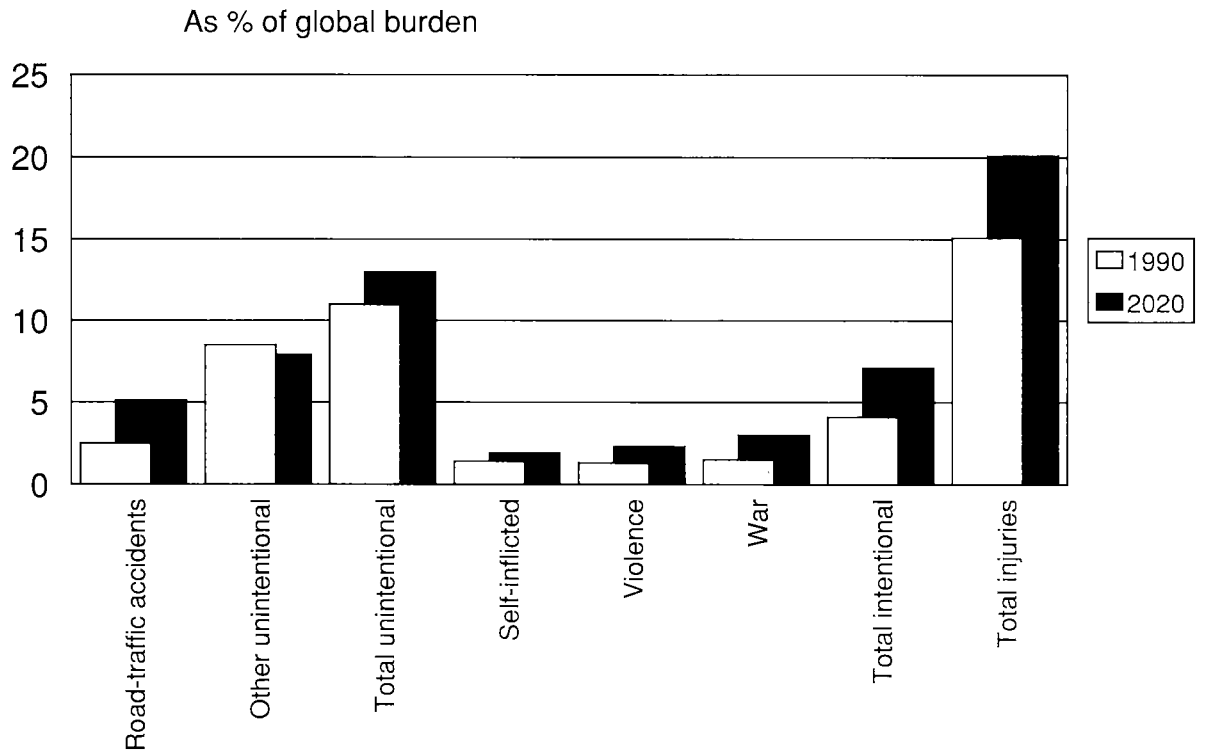
	% of global burden	
Injuries	**1990**	**2020**
All unintentional	11.0	13.0
Road-traffic accidents	2.5	5.1
Other unintentional*	8.5	7.9
All intentional	4.1	7.1
Self-inflicted	1.4	1.9
Violence	1.3	2.3
War-related injuries	1.5	3.0
Total injuries	15.1	20.1

*falls, fires, drownings, etc.

Note: Numbers in this table have been rounded to one decimal place. This leads to rounding errors that prevent the totals for individual conditions from exactly matching the group subtotals.

Source: Annex 1. See the annex for an explanation of the demographic factors responsible for a large proportion of the projected increases (e.g. in war-related injuries).

Figure 5.7 Trends in unintentional and intentional injuries, 1990 and 2020



Source: Annex 1

Table 5.7 Current and projected burden from road-traffic accidents

Region	1990 (% of total regional burden)	2020 (% of total regional burden)
World	2.5	5.1
Sub-Saharan Africa	1.9	5.1
India	2.1	6.5
China	2.1	4.8
Other Asia and islands	2.7	5.2
Latin America/Caribbean	4.1	6.4
Middle Eastern crescent	1.7	3.6
Former socialist economies	4.4	5.2
Established market economies	4.4	3.6
Established market economies and former socialist economies	4.4	4.3
Demographically developing countries	2.2	5.2

Source: Annex 1

hol abuse is a significant factor, and, once again, drivers are not the only ones affected. Drunk pedestrians make up a significant proportion of the fatalities on roads.

Although the increase in injuries from motor vehicles in any population rises with the number of vehicles on the road, the relationship is not a simple one. Mortality rates per vehicle are highest at periods of rapidly increasing use and then, typically, decline as development leads to safer roads, increased safety consciousness such as laws to enforce use of seat-belts and prosecute drunk drivers, better traffic awareness and more roadworthy vehicles. Thus, for example, mortality related to vehicles rose fourfold in the early 1970s in several South-East Asian countries, and similar trends have emerged in Latin America and Africa more recently. At the end of the 1970s, mortality rates per vehicle were 50 times higher in both Ethiopia and Nigeria than in the United States or the United Kingdom at the same period (Jacobs & Sayer 1983). In the developing regions as a whole, there are on average about 3 motor vehicles for every 100 people; in the industrialized countries there are about 50. But in 1990, the region with the heaviest burden of road-traffic accidents was not the established market economies, but the former socialist economies, while the burden in Latin America and the Caribbean was as great as that in the established market economies. The burden from road-traffic accidents in sub-Saharan Africa was fully half as much as that in the established market economies, even though Africa would have to increase its vehicle numbers 17-fold to reach industrialized-country levels of ownership.

As the number of vehicles increases, injury rates in low-income and middle-income regions will continue to rise sharply to overtake rates in the industrialized countries, where injury rates will stabilize (Table 5.7). Health research has barely begun to tackle this issue.

Other unintentional injuries. Burns and fires account for a significant proportion of unintentional injury, predominantly affecting women and children in household settings where cooking is done on open fires or with liquid fuels. Poisoning is also a common problem, both in adults and children. Adults are exposed to poisons through their occupations in agriculture and industry, while a frequent cause of poisoning among inadequately supervised children is the ingestion of paraffin (kerosene) stored in inappropriate containers such as soft-drink bottles. Misuse of medicines such as antimotility agents may also be a growing source of poisoning.

Occupational injuries are much more common in low-income countries, partly because safety is often considered a marginal issue in periods of rapid economic development. The excess risk in low-income countries has persisted throughout the second half of the 20th century. Miners, truck drivers, and factory workers in heavy industry are at particularly increased risk. Farmers exposed to pesticides may be acutely poisoned or damaged by chronic, low-level exposure, with the vast majority of pesticide poisonings being caused by a small minority of highly toxic compounds. The longer-term and delayed consequences of prolonged exposure to other toxic chemicals is also likely to be significant, and has not yet been fully explored. Work by WHO's Office of Global and Integrated Environmental Health has begun to establish common frameworks for assessing risk and exposure.

Risk factors for unintentional injuries. Poverty is an unsafe state in any environment. In the United States, the death rate from unintentional injury is twice as high in low-income areas as in high-income areas. It is not surprising, therefore, that people in low-income countries are at greatest risk. Poor people are more likely to suffer from occupational injury, pedestrian fatality and burn injury fatality. A lack of safety education is one predisposing factor; others include the compounded effects of being marginalized, unemployed, living in overcrowded homes and in an environment of alcohol abuse. Poor people are also less likely to have access to good care if they are injured.

5.2.1.2 Intentional injuries

Violent crime increases during periods of social and economic transition. In the United States in the past

century, rates of violent death reached peaks in the 1930s and again at the present time, while the rates dipped through troughs in the early 1900s and the 1960s. Health researchers have not traditionally regarded violence as their concern but there are good reasons why this should change. Obviously, the significance of violence as a cause of loss of healthy life is one reason. Another is the need for innovative and long-term strategies to prevent violence. It has become clear that the traditional social response to violence—the judicial system of retribution and deterrence—cannot alone meet the challenges. A growing number of health researchers now believe they should become involved in order to seek alternative responses, based on identifying the underlying causes of individuals' behaviour in their environment. In addition there is also an immediate practical need to develop strategies to treat the consequences of violence through emergency services and to minimize the long-term disability and damage.

Criminal homicides account for a large part of violent crime and these crimes are common in all urban areas. In economically disadvantaged regions death rates associated with firearms are higher than in rich regions. Violent crime is often linked with illicit trade. Before drug trafficking became a serious problem in Colombia, the homicide rate per 100 000 inhabitants was around 20. By 1987 it had reached more than 50. In South Africa, national rates of homicide peaked in 1993 at around 90 per 100 000, falling to 85 per 100 000 in 1994. These are among the highest rates in the world. In 1995, South Africa's violent deaths were expected to outnumber deaths from motor vehicle collisions by two to one, and among males aged 15–24 violence in 1992 accounted for three times as many deaths as all other natural and non-natural causes combined (see Table 5.8).

War-related injuries. In sub-Saharan Africa and the Middle Eastern crescent in 1990, more years of healthy life were lost through war than through HIV/AIDS. Projections for this Report indicate that the "burden of war" will increase into the first decades of the 21st century, mainly for demographic reasons (Annex 1). War is increasingly affecting civilian populations, for example through injuries caused by land mines. From a health perspective, wars not only inflict a direct and avoidable injury burden, but they also divert resources from other health care needs and from investment in health services.

Table 5.8 Current and projected global burden from violence (%)

Region	1990	2020
World	1.3	2.3
Sub-Saharan Africa	2.2	4.9
India	0.5	0.9
China	0.8	0.8
Other Asia and islands	0.9	1.4
Latin America/Caribbean	3.2	4.4
Middle Eastern crescent	0.8	1.3
Former socialist economies	1.4	1.3
Established market economies	1.0	1.0

Risk factors for intentional injuries. Young adult men are most likely to be the perpetrators of interpersonal violence of all kinds, while its most frequent victims are women and children. Adolescents are more vulnerable than older adults. Alcohol abuse, poverty, social isolation and overcrowding are important risk factors: in some studies alcohol is believed to account for as many as half of cases of interpersonal violence (see Box 5.2). Sexual violence against women is widespread. Women in South Asia face a significant risk of deliberate burning or forced suicide, often linked to their lack of rights in marital partnerships. Evidence is growing that alcohol misuse plays a significant part in increasing the risks of violence in communities. As Table 5.3 shows, alcohol is already estimated to account for more than 3% of the total burden of disease and injury worldwide.

5.2.2 Current investment

Only limited information has been available to the Committee. However, an assessment of current investment by the public sector in health R&D on motor vehicle safety confirms the degree of neglect of this major cause of disease burden. On average between 1990 and 1992 the amount spent was between US$ 24 million and US$ 33 million a year, compared with US$ 56 billion for health research as a whole. This represents less than US$ 1 for every DALY caused by road-traffic accidents in 1990 (Annex 5). While the motor vehicle industry itself has invested considerably in vehicle safety, other areas of road safety including road design and pedestrian protection have received much less attention.

5.2.3 Assessment of research needs

By nature, this group of conditions is different from the others we have analysed so far. In the assessment of attributable burden, injuries are already grouped by their causes, and an analysis of the reasons for their persistence of the type conducted for noncommunicable diseases, and for the conditions discussed in Chapters 3 and 4, would appear to add little to the process of identifying R&D priorities, at least while globally available data on the impact of various risk factors for injury remain scarce. Moreover, injuries are a highly heterogeneous group and oversimplified assessments of R&D needs for the overall group are unlikely to be meaningful. For these reasons, the Committee has used a less structured procedure for identifying research needs, based on consultation with relevant experts. More than any of the other health challenges discussed in this Report, the subject of injuries has been neglected and the knowledge base is impoverished. The recent and growing recognition of the problem, however, is already stimulating

Box 5.2 Alcohol as a risk factor for injury: the South African experience

Recent studies in South Africa have estimated that around half of the deaths due to trauma each year in adults aged between 14 and 60 can be attributed to alcohol. Unsafe drinking accounts for much of the country's unintentional injury burden: half of all motor traumas and 60% of all pedestrian traumas are linked to alcohol use, and blood alcohol levels are typically higher in injured and dead pedestrians than in drivers. Heavy drinkers are also much more likely to be involved in intentional injury. Some 60% of homicides are linked with alcohol misuse. Contrary to widespread belief, people in rural areas are more likely to be affected than those in the cities.

Alcohol misuse is estimated to cost the country about US$ 1.2 billion a year. South Africa is considering the development of a range of policy instruments to control alcohol misuse and to promote healthier behaviour particularly in younger age groups. These are broadly in line with the policy outlined by the Reconstruction and Development Programme. They include:

- increased excise tax on beer sales to bring in substantial additional revenue;
- warnings and restrictions on alcohol advertising;
- bans on sports promotions;
- enforcement of restrictions on sales to minors;
- enforcement of drunk driving laws;
- health education (school and community programmes funded from excise tax).

It is important to avoid pricing policies that drive people on low incomes away from commercial beers and into producing and drinking larger amounts of illicit home-brews, most of which have a higher alcohol content. It has been estimated that the proposed excise tax above would not act as a sufficient disincentive to stop purchase of commercial beers.

fruitful work to analyse its determinants and identify opportunities for intervention, particularly in Latin America and South Africa.

5.2.4 Priorities for strategic research

Based on consultation with researchers in the field, we conclude that key priorities should include:

- Epidemiological studies (especially social epidemiology) to better understand how patterns, causes and levels of violence are related to socioeconomic development;
- Epidemiological studies to provide better data sets in all countries on the incidence of injuries, their external causes, and the cost-effectiveness of existing interventions against them. This will require much more detailed knowledge of the impact of different types of injury;
- Epidemiological studies to further quantify the links between alcohol abuse and interpersonal violence in different environments;
- Epidemiological studies to measure the risks attached to the possession of firearms in different socioeconomic groups;
- Health policy research to identify the gaps between current capacity and projected required capacity for the provision of cost-effective emergency medical services in rural and urban areas;
- Behavioural research into the determinants of risk-taking behaviour in low-income populations, and particularly among adolescents and young adults. Perceptions of risk and benefit are likely to be very different in low-income settings where individuals often have no option but to take risks, both at work and home. There is an ongoing need for research at the household level in different economic and social settings, together with evaluation of the cost-effectiveness and acceptability of different and carefully targeted risk-reduction strategies. Studies using Essential National Health Research (ENHR) processes (discussed in Chapter 1) may play an important part in increasing understanding of the common determinants of injury.

5.2.5 Opportunities for intervention development and evaluation

The Committee has identified two broad opportunities, one for the prevention of injury and the second for treatment. We discuss them here in turn. The existing knowledge base on effective means to prevent most injuries has been built up largely in the established market economies. A range of interventions have already been found effective. They fall into several distinct categories:

(i) safer products such as cars fitted with seat-belts, air-bags and antilock braking systems; helmets for motorcyclists; guards on dangerous machinery; fireguards for use in homes; childproof caps on storage bottles; high walls or barriers on roadsides;

(ii) fiscal measures, such as taxation on private vehicles combined with subsidies for public transport; price increases through taxation on alcohol to reduce consumption, etc.;
(iii) legislation, such as seat-belt enforcement, occupational safety laws;
(iv) education in safety (although the effectiveness of education in preventing injury is unclear, there is substantial evidence that ignorance plays a large part in the risk-taking of individuals, for example, in handling pesticides, and that there is thus plenty of room for improving people's ability to make safer choices).

Because of the existing knowledge, action to implement national policies for safety can already be justified and an international "Manifesto for Safe Communities" (World Health Organization 1989) has been drawn up with the participation of more than 50 countries. However, effective implementation will require a large amount of operational research. Most of the evidence for the efficacy of such measures comes from the established market economies. The Committee therefore considers that an initial priority for intervention development is:

- Evaluation of selected interventions in low-income and middle-income countries to identify the most cost-effective means of reducing injury burden through prevention. The most desirable interventions are likely to include taxes on alcohol, campaigns against drunk driving, legislation to improve road safety and vehicle safety, and locally tailored restrictions on firearms.

Additional interventions may include restrictions on the use of video tapes and arcade games for children that portray violence without demonstrating its consequences. Reducing the burden from suicide is likely to be possible through controls on access to poisons and medications.

However, all such restrictions must be assessed in local contexts. In environments of low social cohesion and political instability, illicit markets for banned or restricted products may quickly develop, often with more damaging effects. Evaluation research of various antiviolence measures is an urgent priority, and R&D in this area will need to take careful account of the views of households and communities if it is to be successful. Few control measures are likely to succeed without intersectoral collaboration. Industry lobbies have been powerful in maintaining the supply of potentially dangerous products in markets in industrialized and developing countries alike. Health policy researchers will need to evaluate the possibilities for different types of intersectoral initiatives to reduce the availability of harmful products.

The treatment of injuries, meanwhile, is a severely neglected area of R&D in low-income countries. It requires considerable R&D investment, particularly in the development of products such as prostheses, and in developing better emergency medical services to provide cost-effective, often lifesaving care. This will require the pilot testing of better communications systems, research and training in the use of triage by health workers, and systematic treatment to prevent the infectious complications of wounds. In the Committee's view, therefore, researchers and those who invest in research should substantially increase resources to:

- Develop and evaluate algorithms for emergency treatment and rehabilitation of injured persons, including the provision of advice on avoiding further injury, in rural as well as urban areas.

Pilot studies should begin as soon as possible in both urban and rural areas, with support from ministries of health and other health service providers with an incentive to provide cost-effective emergency care. Larger studies should follow when feasible.

Box 5.3 outlines the Committee's proposal for organizational initiatives to take up the challenge of noncommunicable diseases and injuries.

5.3 Chapter summary and recommendations

Noncommunicable diseases are rapidly becoming the leading sources of disease burden in low-income and

Box 5.3 Key R&D investments for noncommunicable diseases and injuries

In contrast to Chapters 3 and 4, the Committee has chosen not to select a list of "best buys" for R&D in noncommunicable diseases and injuries from the broad set of intervention opportunities identified in sections 5.1.5 and 5.2.5 above. Instead, we believe this task could be better performed by those with specialist expertise in the relevant areas, once they have access to adequate data on the cost-effectiveness of existing and desired interventions in low-income and middle-income countries. In order to speed this process and to focus efforts in line with the scale of the projected epidemics, we recommend two specific initiatives:

- A Special Programme or Initiative for Research and Training on Noncommunicable Diseases and Healthy Aging
- A Special Programme or Initiative for Research, Training and Capacity-Building in Injuries

These are outlined in the Recommendations section below.

middle-income countries. By 2020, noncommunicable diseases are together projected to account for almost three-fifths of the total burden; among these, ischaemic heart disease and depression are expected to be the principal causes, each accounting for almost 6% of the total burden. Depression is projected to be the leading cause of disease burden in developing countries by the third decade of the 21st century, while tobacco use will be responsible for more death and disability than any single disease. By 2020, injuries may rival communicable diseases in epidemiological importance and are projected to outstrip communicable diseases in Latin America and the Caribbean, China, and all other Asian countries except India. In view of these trends and the lack of cost-effective interventions for many of these diseases and injuries, the ongoing research devoted to them in low-income and middle-income countries is wholly inadequate.

This is not to deny the potential relevance of the enormous investments in NCD research in the high-income countries in the areas of basic science, intervention development and epidemiology; some results of these efforts will undoubtedly be of value in developing countries.What is lacking is development and evaluation of interventions that must fit into far tighter budget constraints than those of the high-income countries, as well as understanding of epidemiologic and pathogenic factors that may differ markedly by region.

Specific support from major investors in the established market economies to the developing countries for noncommunicable diseases currently represents less than 5% of their total health research budget. Research into tobacco receives less than US$ 5 for every DALY attributed to it. And publicly funded research into motor vehicle safety receives even lower levels of funding.

A priority for the development of health policy and health services is to increase the availability of reliable, basic data on the prevalence and incidence of noncommunicable diseases and the influence of their underlying risk factors in the populations of low-income and middle-income countries. While this research continues, however, a rapid parallel effort to develop cost-effective interventions for noncommunicable diseases—both in public health and in clinical services—is essential. Among these, tobacco control will be paramount. Research is also required to increase knowledge of the societal and behavioural determinants of injuries, particularly violence and road-traffic accidents, the impact of risk factors for injury such as alcohol, and the cost-effectiveness of different prevention and treatment strategies. Such research will require intersectoral collaboration.

Recommendations

1. Faced with rapidly growing burdens of noncommunicable diseases, low-income and middle-income countries should significantly increase their relevant strategic research in epidemiology, behavioural science and health policy with the aim of reliably monitoring the true prevalence and trends of these conditions in their populations, and understanding their determinants. Basic data on mortality, morbidity and disability are currently inadequate in many regions, as are data on the country-specific and region-specific levels and determinants of environmental and behavioural risk factors. Low-cost methods for collecting reliable data, such as the use of disease surveillance points, must therefore be developed. In contrast to the need for epidemiological and behavioural research, biomedical science relevant to these conditions is already comparatively well supported in the established market economies. However, genuine differences in the characteristics of environments and populations will occasionally require additional biomedical research in some regions—as, for example, in seeking explanations for the observed high risk in South Asians of diabetes and heart disease.

2. The development and evaluation of algorithms and policy instruments for the cost-effective prevention, diagnosis, treatment and rehabilitation of noncommunicable diseases is an immediate priority for support by governments and other investors. In particular, policy instruments for effective tobacco control are required, as are efforts to increase health workers' awareness of psychiatric disorders in primary health care so that existing treatments may reach more of those who need them. By contrast, the development of new drugs to deal with noncommunicable diseases should claim a low priority on the resources of low-income and middle-income countries because of massive investment in this area in the established market economies.

3. Research to respond to the injury epidemic must include an immediate effort to build data sets within countries and for international comparison of the incidence, prevalence and risk factors for different types of injury. Possible links between each type of injury and a range of modifiable risk factors such as alcohol use should be quantified. The development and evaluation of improved strategies for preventing and treating injuries in low-income countries is a priority.

4. To provide the necessary foci for these efforts in R&D on noncommunicable diseases and injuries, the Committee recommends two specific new R&D initiatives. First, we propose the establishment of a Special Programme for Research and Training on Noncommunicable Diseases and Healthy Aging. It should improve the quality and quantity of data on disease burden and mortality from noncommunicable diseases worldwide, with particular emphasis on gaining greater understanding of the risk factors and determinants of

these diseases in different settings. It should audit existing treatment strategies in different countries, and—most importantly—invest in the development of cost-effective and sustainable interventions for use in low-income countries. Second, we propose a Special Programme or Initiative for Research, Training and Capacity-Building on Injuries. The initiative or programme should take advantage of growing relevant expertise in Latin America and South Africa. It should coordinate efforts to improve data on the burden of injuries, both intentional and unintentional, particularly those that can be readily prevented. Its aim should be the development of interventions, from products to policy instruments, that can prevent injuries, and the improvement of emergency services to deal with their consequences, especially in low-income countries. Both programmes or initiatives should serve to increase public awareness of the importance of the health problems with which they are concerned.