SUMMARY

GLOBAL BURDEN OF DISEASE AND INJURY SERIES

THE GLOBAL BURDEN OF DISEASE

EDITED BY
CHRISTOPHER J. L. MURRAY
ALAN D. LOPEZ

WORLD HEALTH ORGANIZATION
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THE GLOBAL BURDEN OF DISEASE

A comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020

EDITED BY

CHRISTOPHER J. L. MURRAY
HARVARD UNIVERSITY
BOSTON, MA, USA

ALAN D. LOPEZ
WORLD HEALTH ORGANIZATION
GENEVA, SWITZERLAND

WORLD HEALTH ORGANIZATION

HARVARD SCHOOL OF PUBLIC HEALTH

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Contents

This booklet is a summary of the *The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability from Diseases, Injuries, and Risk Factors in 1990 and Projected to 2020*, edited by Christopher J.L. Murray and Alan D. Lopez, published by the Harvard School of Public Health on behalf of the World Health Organization and the World Bank and distributed by Harvard University Press. It also contains examples of the detailed information on the epidemiology of 240 conditions around the world published in *Global Health Statistics: A Compendium of Incidence, Prevalence and Mortality Estimates for Over 200 Conditions*, by Christopher J.L. Murray and Alan D. Lopez, published by the Harvard School of Public Health on behalf of the World Health Organization and the World Bank and distributed by Harvard University Press.

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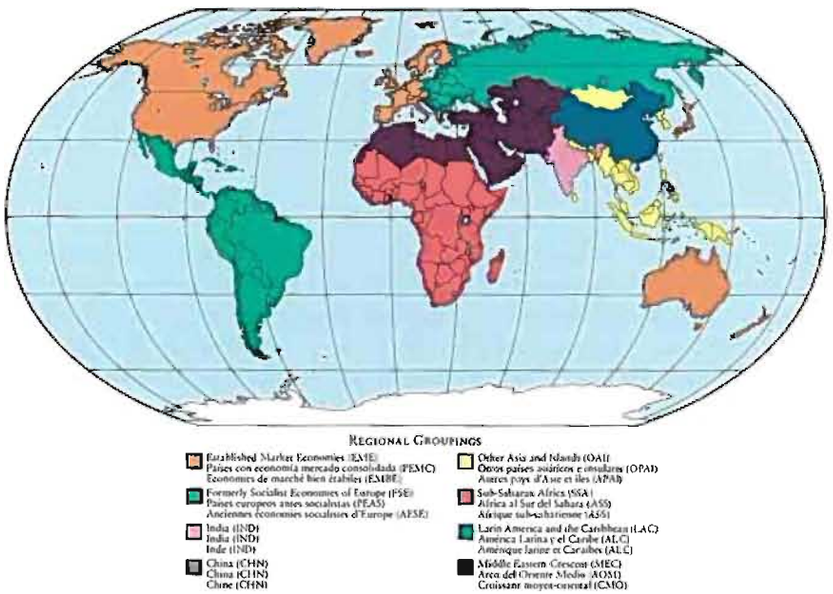
"Publication of the *Global Burden of Disease and Injury Series* marks the transition to a new era...I firmly predict that by the turn of the century the official reporting of health outcomes in dozens of countries and globally will embody the approach and standards described in this series."

Dean T. Jamison, Professor of Public Health, University of California Los Angeles and Chairman, WHO Ad Hoc Committee of Health Research Relating to Future Intervention Options



Introduction

The next two decades will see dramatic changes in the health needs of the world's populations. In the developing regions where four-fifths of the planet's people live, noncommunicable diseases such as depression and heart disease are fast replacing the traditional enemies, such as infectious diseases and malnutrition, as the leading causes of disability and premature death. By the year 2020, noncommunicable diseases are expected to account for seven out of every ten deaths in the developing regions, compared with less than half today. Injuries, both unintentional and intentional, are also growing in importance, and by 2020 could rival infectious diseases worldwide as a source of ill health.

These changes are expected because of the rapid aging of the developing world's populations. As a population's birth rate falls, the number of adults relative to children increases, and the population's commonest health problems become those of adults rather than those of children. In China, some other parts of Asia and Latin America, this so-called "epidemiological transition" is already much further advanced than many public health specialists appreciate. In all regions the rapidity of change, and the very large absolute numbers involved, will pose serious challenges to health-care systems and force difficult decisions about the allocation of scarce resources. Yet, until now, many governments have lacked even the most basic data they needed to inform debate and to assess priorities for public health.

Now, for the first time, this gap has been filled with a landmark publication. Researchers at the Harvard School of Public Health and the World Health Organization, with more than 100 collaborators from around the world, have produced a comprehensive, internally consistent and comparable set of estimates of current patterns of mortality and disability from disease and injury for all regions of the world, with projections to the year 2020. *The Global Burden of Disease and Injury Series*, the ten-volume result of their study, is a unique resource that

provides policy-makers with their first comprehensive picture of the world's current and future health needs.

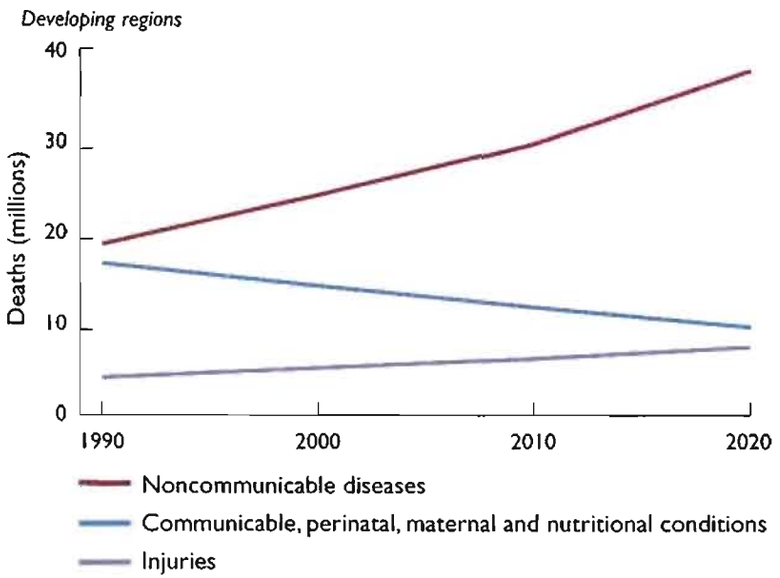
Deaths from noncommunicable diseases are expected to climb from 28.1 million a year in 1990 to 49.7 million by 2020—an increase in absolute numbers of 77 per cent.

The researchers involved in this ambitious five-year effort developed a new approach to measuring health status. Their method quantifies not merely the number of deaths but also the impact of *premature* death and *disability* on a population, and combines these into a single unit of measurement of the overall "burden of disease" on the population. The series also presents the first estimates of the proportion of mortality and disability that can be attributed to certain risk factors for disease, including tobacco, alcohol, poor water and sanitation, and unsafe sex.

A TIMELY ASSESSMENT OF GLOBAL HEALTH NEEDS

Far from confirming what was already known, the study offers significant surprises. Overall, it shows that the epidemiological transition is already

Figure 1 Projected trends in death by broad cause Group, developing regions



well advanced, suggesting that public health policy, with its traditional emphasis on infectious disease, has not kept pace with events. In addition, it makes a number of startling individual observations. Just four examples are highlighted here:

- The burdens of mental illnesses, such as depression, alcohol dependence and schizophrenia, have been seriously underestimated by traditional approaches that take account only of deaths and not disability. While psychiatric conditions are responsible for little more than one per cent of deaths, they account for almost 11 per cent of disease burden worldwide.
- Adults under the age of 70 in Sub-Saharan Africa today face a higher probability of death from a noncommunicable disease than adults of the same age in the Established Market Economies.
- Men living in the Formerly Socialist Economies of Europe have a disturbingly poor, and deteriorating, health status, including a 28 per cent risk of death between the ages of 15 and 60.
- By 2020, tobacco is expected to kill more people than any single disease, surpassing even the HIV epidemic.

Adults under the age of 70 in Sub-Saharan Africa today face a higher probability of death from a noncommunicable disease than adults of the same age in the Established Market Economies.

The Global Burden of Disease study (GBD) has involved an estimated forty person-years of effort. An extraordinarily large volume of data—on 483 separate sequelae of 107 diseases and injuries, and 14 million death certificates—has been subjected to rigorous analysis using both newly developed and well-established methods. Volume I, *The Global Burden of Disease*, summarizes the key concepts, methods and results and Volume II, *Global Health Statistics*, presents the mass of underlying epidemiological and demographic data. Details of the remaining eight volumes, which deal with specific conditions and country-based analyses, are shown on page 43 of this booklet.

The burden of disease and injury has been calculated for eight demographic regions (see Map): the Established Market Economies (largely the OECD countries) (EME); the Formerly Socialist Economies of Europe (FSE); India (IND); China (CHN); Other Asia and Islands (OAI); Sub-Saharan Africa (SSA); Latin America and the Caribbean (LAC) and the Middle Eastern Crescent (MEC). Burden is analysed by five age groups, by sex and by cause.

This booklet presents the key findings of Volume I. The first section summarizes the concepts and methods involved in developing a single measure of health status. Sections 2 through 5 present the results for the 1990 assessments and section 6 summarizes the 2020 projections. The final section provides details and samples of the content of Volumes I and II.

Figure 2 Change in the rank order of disease burden for 15 leading causes, world, 1990–2020

Disease burden measured in Disability-Adjusted Life Years (DALYs)

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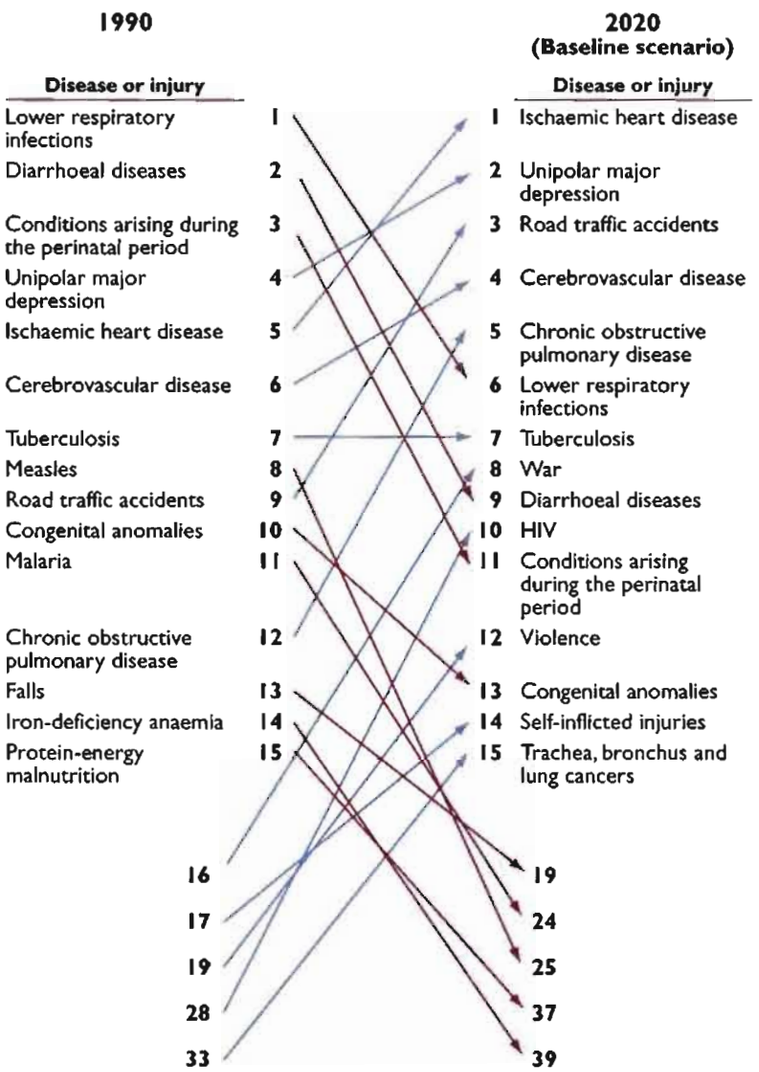

Figure 3 DALYs attributable to diarrhoea, HIV and tobacco, 1990–2020 (baseline scenario)

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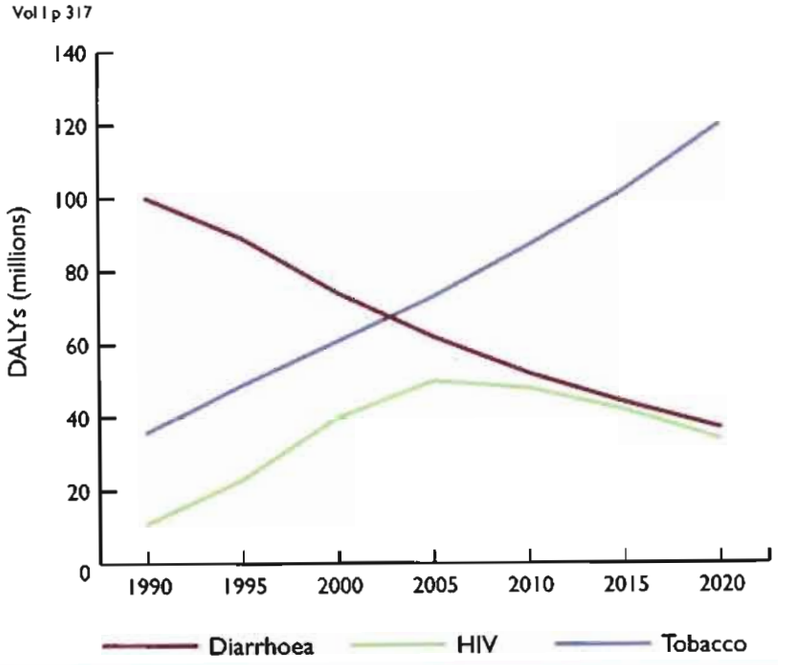
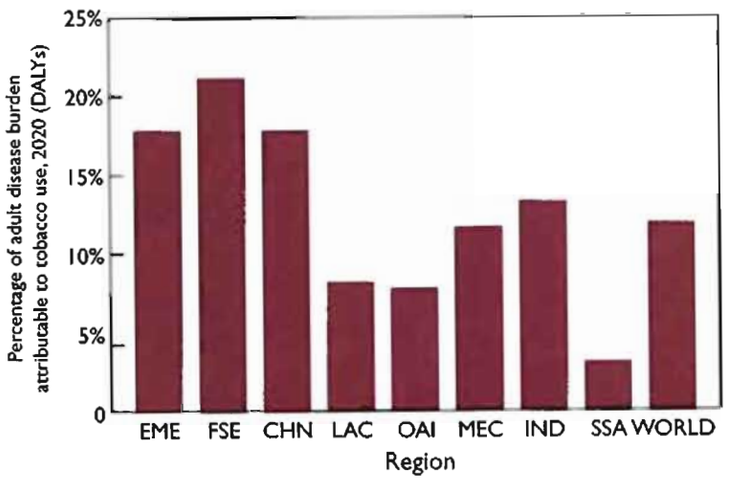


Figure 4 By 2020, tobacco is expected to cause more premature death and disability than any single disease

Vol I p 316 (See Map for explanation of regional composition)



1. This section summarizes Volume 1, Chapter 1, pp 1 to 98.

1. The GBD's approach to measuring health status

1.1 Why the GBD is different

In general, statistics on the health status of populations suffer from several limitations that reduce their practical value to policy-makers:

- First, they are partial and fragmented. In many countries even the most basic data—the number of deaths from particular causes each year—are not available. Even where mortality data are available, they fail to capture the impact of non-fatal outcomes of disease and injury, such as dementia or blindness, on population health.
- Second, estimates of the numbers killed or affected by particular conditions or diseases may be exaggerated beyond their demographically plausible limits by well-intentioned epidemiologists who also find themselves acting as advocates for the affected populations in competition for scarce resources. If the currently available epidemiological estimates for all conditions were right, some people in a given age group or region would have to die twice over to account for all the deaths that are claimed.
- Third, traditional health statistics do not allow policy-makers to compare the relative cost-effectiveness of different interventions, such as, for example, the treatment of ischaemic heart disease versus long-term care for schizophrenia. At a time when people's expectations of health services are growing and funds are tightly constrained, such information is essential to aid the rational allocation of resources.

The GBD set out to address these problems with three explicit aims:

1. to incorporate non-fatal conditions into assessments of health status;
2. to disentangle epidemiology from advocacy in order to produce objective, independent and demographically plausible assessments of the burdens of particular conditions and diseases; and
3. to measure disease and injury burden in a currency that can also be used to assess the cost-effectiveness of interventions, in terms of the cost per unit of disease burden averted.

1.2 A single measure of disease burden

In order to capture the impact of both premature death and disability in a single measure, a common currency is required. Since the late 1940s, researchers have generally agreed that time is an appropriate currency: time (in years) lost through premature death, and time (in years) lived with a disability. A range of such time-based measures has been developed in

different countries, many of them variants of the so-called Quality-Adjusted Life Year or QALY. For the GBD, an internationally standardized form of the QALY has been developed, called the Disability-Adjusted Life Year (DALY). The DALY expresses years of life lost to premature death and years lived with a disability of specified severity and duration. One DALY is thus one lost year of healthy life. Here, a "premature" death is defined as one that occurs before the age to which the dying person could have expected to survive if they were a member of a standardized model population with a life expectancy at birth equal to that of the world's longest-surviving population, Japan.

One DALY is one lost year of healthy life.

To calculate total DALYs for a given condition in a population, years of life lost (YLLs) and years lived with disability of known severity and duration (YLDs) for that condition must each be estimated, and then the total summed. For example, to calculate DALYs incurred through road traffic accidents in India in 1990, add the total years of life lost in fatal road accidents and the total years of life lived with disabilities by survivors of such accidents.

1.3 A society's values are explicitly built into its measures of health status

It might appear that quantifying disease burden is a neutral exercise, entirely free of value choices. However, this is far from the case. Disease burden is, in effect, the gap between a population's actual health status and some "ideal", or reference status. In order to measure burden, a society has to decide what the ideal or reference status should be. This involves making five value choices:

- How long "should" people live? If health researchers are to estimate how many years of life are lost through death at any given age, they must decide on the number of years for which a person at that age should expect to survive in the ideal, or reference, population. That could be, for example, 60, 80 or 90 years from birth.
- Are years of healthy life worth more in young adulthood than in early or late life?
- Is a year of healthy life now worth more to society than a year of healthy life in 30 years' time?
- Are all people equal? For example, should one socioeconomic group's years of healthy life count for more than another's?
- How do you compare years of life lost due to premature death and years of life lived with disabilities of differing severities?

Health researchers developing a measure of disease burden must recognize their responsibility to reflect societies' preferred answers to these five questions, but also to guard against and "filter out" unjustifiable preferences such as racism, sexism or economic discrimination that may be institutionalized in certain societies. It is unlikely that any measure can reflect a perfect vision of the ideal society; but its choices should be acceptable to as many people of as many different cultures as possible.

The Egalitarian Principles on which the DALY Is Based

The GBD has sought to develop a measure based on explicit and transparent value choices that may be readily debated and modified. Overall, the DALY has a strongly egalitarian flavour. It is built on the principle that only two characteristics of individuals that are not directly related to their health—their age and their sex—should be taken into consideration when calculating the burden of a given health outcome in that individual. Other characteristics, such as socioeconomic status, race or level of education, are not considered, so, for example, years of healthy life lived by the director of a bank are regarded as no more valuable than those lived by a poor rural peasant. In the remainder of this section, the social choices that affect the DALY are each discussed briefly.

DALYs are intended to be a transparent tool to enhance dialogue on the major health challenges facing humanity.

How Long Should People Live?

In accordance with the GBD's egalitarian principles, the study assumes a standard life table for all populations, with life expectancies at birth fixed at 82.5 years for women and 80 years for men. A standard life expectancy allows deaths in all communities at the same age to contribute equally to the burden of disease. Alternatives, such as using different life expectancies for different populations that more closely match their actual life expectancies, interfere with the egalitarian principle. For example, if a 35 year-old woman dies in childbirth in an African country where she might have expected to live another 30 years, her years of life lost would be deemed unfairly to be fewer than those for a 35 year-old woman who dies in childbirth in Japan, when she might otherwise have expected to live another 48 years.

Life expectancy is not equal for men and women. Accordingly, the GBD has given men a lower reference life expectancy than women. However, since much of the difference between men and women is determined by men's higher exposure to various risks such as alcohol, tobacco and occupational injury, rather than purely biological differences, this choice is arguably a form of discrimination against men and could be modified in future revisions of the DALY.

Are Years of Healthy Life Worth More in Young Adulthood than in Early or Late Life?

If individuals are forced to choose between saving a year of life for a 2 year-old and saving it for a 22 year-old, most prefer to save the 22 year-old. A range of studies confirms this broad social preference to "weight" the value of a year lived by a young adult more heavily than one lived by a very young child or an older adult. Adults are widely perceived to play a critical role in the family, community and society. The GBD researchers therefore incorporated age-weighting into the DALY. They assume that the relative value of a year of life rises rapidly from zero at birth to a peak in the early twenties, after which it steadily declines.

Figure 5 The relative value of a year of life lived at different ages, as incorporated into DALYs

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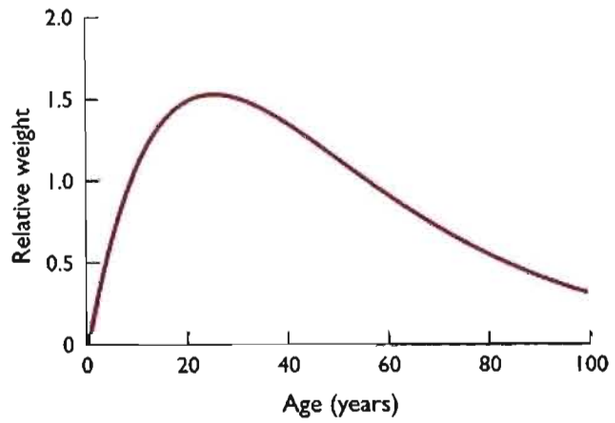

Is a Year of Healthy Life Now Worth More to Society than a Year of Healthy Life in 30 Years' Time?

If a person is offered $100 today or $100 in a year's time, that person is likely to prefer $100 today. Future dollars are thus discounted—valued lower—against current dollars. Whether a year of healthy life, like a dollar, is also deemed to be preferable now rather than later, is a matter of intense debate among economists, medical ethicists and public health planners, because discounting future health affects both measurements of disease burden and estimates of the cost-effectiveness of an intervention.

There are arguments for and against discounting and *The Global Burden of Disease* discusses them in depth. The GBD researchers decided, however, to discount future life years by 3 per cent per year. This means

that a year of healthy life bought for 10 years hence is worth around 24 per cent less than one bought for now, as discounting is represented as an exponential decay function. Because the impact of discounting is significant, the GBD publishes alternative results based on DALYs without discounting.

If individuals are forced to choose between saving a year or life for a 2 year-old and saving it for a 22 year-old, most prefer to save the 22 year-old.

Discounting future health reduces the relative impact of a child death compared with an adult death. For example, with age-weighting also incorporated, a year-old girl's death causes a loss of 34 years of life while a 25 year-old woman's death results in a loss of 33 years of life. Discounting also reduces the value of interventions that pay off largely in the future—such as vaccinating against hepatitis B, which may prevent thousands of cases of liver cancer, but some decades later.

How Do You Compare Time Lost Due to Premature Death with Time Lived with Disability?

While death is not difficult to define, disability is. All non-fatal health outcomes of disease are different from each other in their causes, nature, and their impact on the individual, and the impact on the individual is in turn mediated by the way the surrounding community responds. Yet, in order to quantify time lived with a non-fatal health outcome and assess disabilities in a way that will help to inform health policy, disability must be defined, measured and valued in a clear framework that inevitably involves simplifying reality.

There is surprisingly wide agreement between cultures on what constitutes a severe or a mild disability. For example, a year lived with blindness appears to most people to be a more severe disability than a year lived with watery diarrhoea, while quadriplegia is regarded as more severe than blindness.These judgements must be made formal and explicit if they are to be incorporated into measurements of disease burden.

Two methods are commonly used to formalize social preferences for different states of health. Both involve asking people to make judgements about the trade-off between quantity and quality of life. This can be expressed as a trade-off in time (how many years lived with a given disability would you trade for a fixed period of perfect health?) or a trade-off between persons (would you prefer to save one life-year for 1000 perfectly healthy individuals as opposed to saving one life-year for 2000 individuals in a worse health state?). While such trade-offs may affront our perceptions about what is morally acceptable, they are practised implicitly throughout the world's health care systems. The philosophy of

Table 1 Gauging the severity of disability: disability classes and weights set by the GBD protocol for 22 indicator conditions

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Disability class	Severity weights	Indicator conditions
1	0.00–0.02	Vitiligo on face, weight-for-height less than 2 standard deviations
2	0.02–0.12	Watery diarrhoea, severe sore throat, severe anaemia
3	0.12–0.24	Radius fracture in a stiff cast, infertility, erectile dysfunction, rheumatoid arthritis, angina
4	0.24–0.36	Below-the-knee amputation, deafness
5	0.36–0.50	Rectovaginal fistula, mild mental retardation, Down syndrome
6	0.50–0.70	Unipolar major depression, blindness, paraplegia
7	0.70–1.00	Active psychosis, dementia, severe migraine, quadriplegia

Note: These weights were established using the person trade-off method with an international group of health workers who met at WHO in Geneva in August 1995. Each condition is actually a detailed case. For example, angina in this exercise is defined as reproducible chest pain, when walking 50 meters or more, that the individual would rate as a 5 on a subjective pain scale from 0 to 10.

the GBD is that the more explicitly these preferences are set out, the more meaningfully they may be debated.

The GBD therefore developed a protocol based on the person trade-off method. In a formal exercise involving health workers from all regions of the world, the severity of a set of 22 indicator disabling conditions—such as blindness, depression, and conditions that cause pain—was weighted between 0 (perfect health) and 1 (equivalent to death). These weights were then grouped into seven classes where class I has a weight between 0.00 and 0.02 and Class VII a weight between 0.7 and 1(see Table 1).

Despite their diverse cultural backgrounds, the participants reached consensus on these weights. Their choices also closely match the pooled results of nine additional exercises with other participants using the same protocol (Figure 6).

In essence, the weight is set by the number of people with a given condition whose claim on a fixed healthcare budget is equal, in the judgement of a partipant, to that of 1000 healthy people. For example, if the participant judges that 1000 entirely healthy people would have an equal claim on the resources as 8000 people with some severe disability, the weight assigned to that particular disability is equal to 1 minus 1000 divided by 8000, or 0.875. If 1000 entirely healthy people were judged to have an equal claim on the resources as 2000 people with a particular, less severe, disability, the weight assigned would be equal to 1 minus 1000 divided by 2000, or 0.5.

For the GBD protocol, each participant is asked two versions of the person trade-off question, one about extending life for people in a given health state versus extending life for healthy people, the second about

Figure 6 In close agreement: weights set for 22 indicator disabling conditions based on the combined results of nine exercises using the GBD protocol, compared with the results of the Geneva meeting

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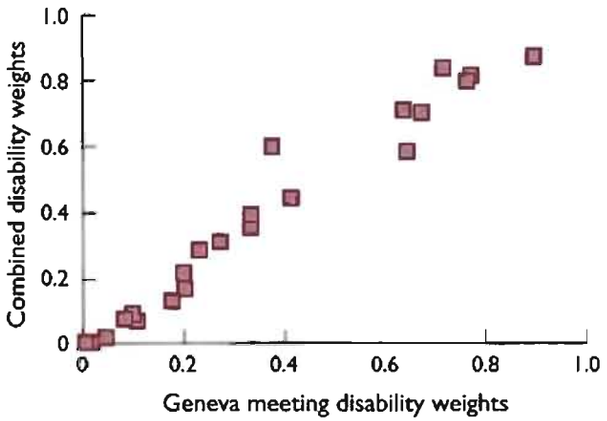

giving health back to people in a given health state versus extending life for healthy people. Two questions are asked because people's answers to each one are invariably inconsistent with the other, and the process of making them consistent forces the participant to think through the implications of their decision in greater depth.

The implications of choosing between the claims of different groups in a society are profound, so the process of setting weights cannot be undertaken lightly. While some other studies have used relatively rapid methods, such as telephone surveys, the GBD protocol is a deliberative process in which a comparatively small group of participants (between 8 and 12) are confronted with the implications of their decision, encouraged to discuss their choices with their peers, and allowed to revise their initial choices. This is time-consuming: at most 20–25 conditions can be discussed in a full working day. Once the 22 indicator conditions have been weighted, the participants assigned the remaining conditions across the seven classes.

1.4 How much do different value choices affect the results?

To gauge the impact of changing these social choices on the final measures of disease burden, the GBD researchers re-calculated their assessments with alternative age-weighting and discount rates, and with alternative methods for weighting the severity of disabilities.

Overall, the rankings of diseases and the distribution of burden by broad cause Group are largely unaffected by age-weighting and only slightly affected by changing the method for weighting disability. Changes to the discount rate, by contrast, may have a more significant effect on the overall results. A higher discount rate results in an increased burden in older age groups, while a lower discount rate results in an increased burden in younger age groups. Changes in the age distribution of burden, in turn, affect the distribution by cause, because communicable and perinatal conditions are commonest in children while noncommunicable diseases are commonest in older adults. The most significant effect of changing the discount and age weights is to reduce the importance of several psychiatric conditions (Figure 7).

Ultimately, however, the accuracy of the underlying basic epidemiological data from which disease burden is calculated will influence the final results much more than the discount rate, the age weight, or the disability weighting method. If, for example, estimates of the incidence of blindness are off by a factor of two, then it follows that this will be reflected in the results. The GBD researchers conclude that researchers' efforts should be invested in improving the basic data rather than in spending excessive energy on analysing the effects of small adjustments to the measure itself.

Figure 7 Relationship between the rank order of causes of global burden using DALYs calculated without age-weighting and discounting and standard DALYs calculated with age-weighting and a three per cent discount rate, 1990 (highest rank is the largest cause)

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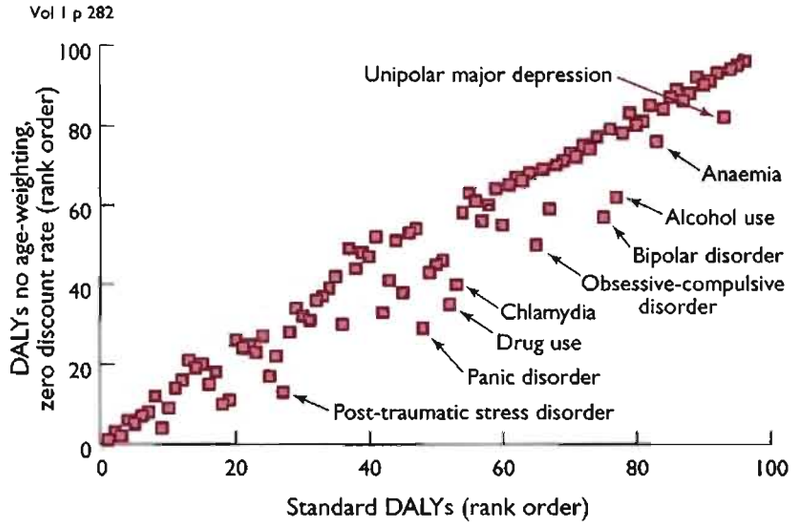


2. How the world dies today

Most developing countries still have only limited information about how their populations die. One of the chief objectives of the GBD has been to develop comprehensive internally consistent estimates of how many people died of each major cause in 1990 worldwide. No such data set was available before the GBD began work. The methods are briefly described, followed by a selection of key results.

2.1 How the GBD estimated the deaths due to each cause

Deaths were classified using a tree structure. The first level of disaggregation comprises three broad cause Groups:

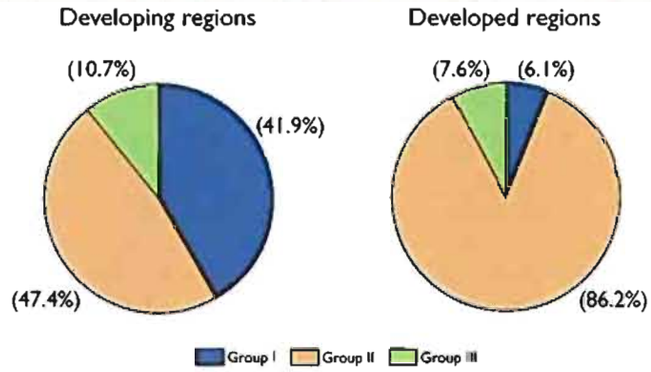
- Group I: Communicable, maternal, perinatal and nutritional conditions;
- Group II: Noncommunicable diseases; and
- Group III: Injuries.

Each group was then subdivided into sub-categories: for example, cardiovascular diseases and malignant neoplasms (cancers) are two sub-categories of Group II. Beyond this level, there are two further disaggregation levels so that 107 individual causes for which codes have been included in the Ninth Revision of the International Classification of Diseases (ICD-9), such as tuberculosis, stomach cancer, or road traffic accidents, can be listed separately.

A demographic data set giving information on population size and the distribution of deaths for each region was developed especially for the GBD. Next, to reach estimates on the number of deaths by cause, the researchers drew on four broad sources of data:

- *Vital registration systems*. These are complete only for the Established Market Economies and the Formerly Socialist Economies of Europe, but some vital registration information is available for all regions except China, India and Sub-Saharan Africa (excepting South Africa).
- *Sample death registration systems*. In China, a set of 145 Disease Surveillance Points, representative of both rural and urban areas, and covering about 10 million people, provides information on deaths by cause. In India, Maharashtra State provides full medical certification for at least 80 per cent of urban deaths, while a rural surveillance system including more than 1300 primary health care centres nationwide was used to assess rural death patterns.
- *Epidemiological assessments*. Epidemiologists have made estimates of deaths for specific causes, such as malaria, in certain regions. These estimates combine information from surveys on the incidence or prevalence of the disease with data on case-fatality rates for both treated and untreated cases.

Figure 8 Deaths by broad cause Group, 1990



- *Cause-of-death models*. Models are used to check the validity of existing data by putting demographic limits on epidemiological estimates. Such models estimate the distribution of deaths by cause in a population from historical studies of the relationship between deaths from twelve broad groups of causes, such as cardiovascular diseases and infectious diseases, and the total number of deaths. The models developed for this study drew on a dataset of 103 observations from 67 countries between 1950 and 1991.

2.2 Results: deaths in 1990

Worldwide, one death in every three is from a Group I cause (communicable, maternal, and perinatal conditions and nutritional deficiencies). Virtually all of these deaths are in the developing regions. One death in ten is from Group III causes (injuries) and just over half of all deaths are from Group II causes (noncommunicable diseases). Figure 8 shows the proportionate burden from each cause for developing and developed regions.

More surprising, perhaps, is the finding that, for several major developing regions, more people already die of Group II causes than Group I causes. In Latin America and the Caribbean, there are almost twice as many deaths from noncommunicable diseases as from Group I causes. In China, there are four-and-a-half times as many deaths from noncommunicable diseases as from Group I causes. The balance has also tipped towards Group II causes in the Middle Eastern Crescent and the region comprising Asia beyond India and China, and the Pacific islands(OAI). Only in India and Sub-Saharan Africa do Group I causes still dominate, accounting for 51 per cent and 65 per cent of deaths respectively.

The results also dispel any remaining notions that noncommunicable diseases are related to affluence. When the estimates are expressed in terms of the probability of dying at a given age in a given region, a striking picture

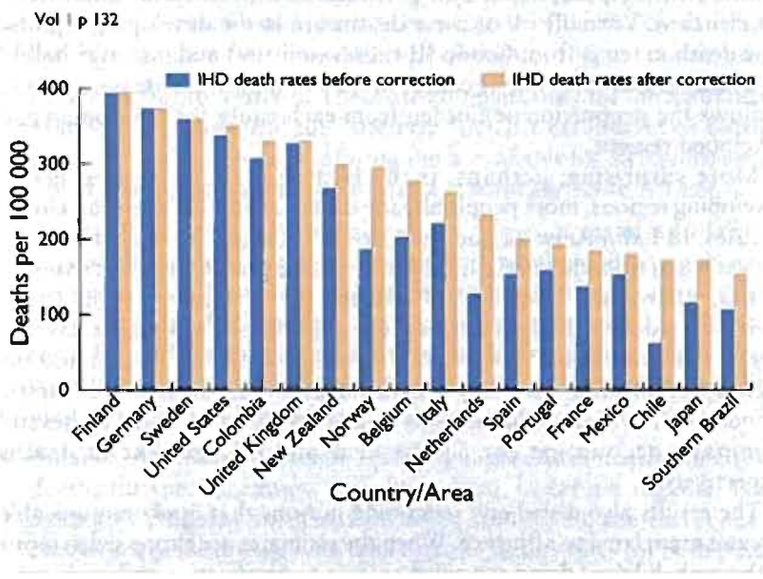
2. This section summarizes Volume 1, Chapter 3, pp 116 to 200.

Correcting for miscoding and "garbage" codes

Under the rules of the International Classification of Diseases, deaths must be assigned to one cause only, and this must be the underlying cause: for example, if someone has a heart attack and later dies of pneumonia in hospital, the cause of death must be recorded as ischaemic heart disease. Miscoding of deaths—that is, assigning the death to the "wrong" cause in ICD-9, occurs regularly in all countries with registration systems. For example, the choice of codes for cardiovascular diseases is notoriously variable between industrialized countries, with a significant proportion of ischaemic heart disease deaths being attributed to ill-defined codes such as heart failure. When national statistics are corrected for probable miscoding, substantially different pictures emerge. Miscoding may help to account, for example, for some of the unexplained variation in rates of death from ischaemic heart disease between the developed nations. Before correction, the national data suggest there are more than six times as many deaths from ischaemic heart disease in adults in Finland (the country with the highest rate) as in Japan (the country with the lowest rate). After correction, the difference is reduced to 2.3 to 1. To correct for such miscoding, the GBD developed specific algorithms to redistribute the miscoded deaths.

A varying proportion of deaths in all countries are ascribed to so-called "garbage" codes, such as "Symptoms, signs, and ill-defined conditions," which account for less than 3 per cent of certificates in the Established Market Economies but as many as one-fifth in some developing countries. These deaths are redistributed across other causes.

Box Figure 1 Mortality rates from ischaemic heart disease for selected countries, corrected and uncorrected



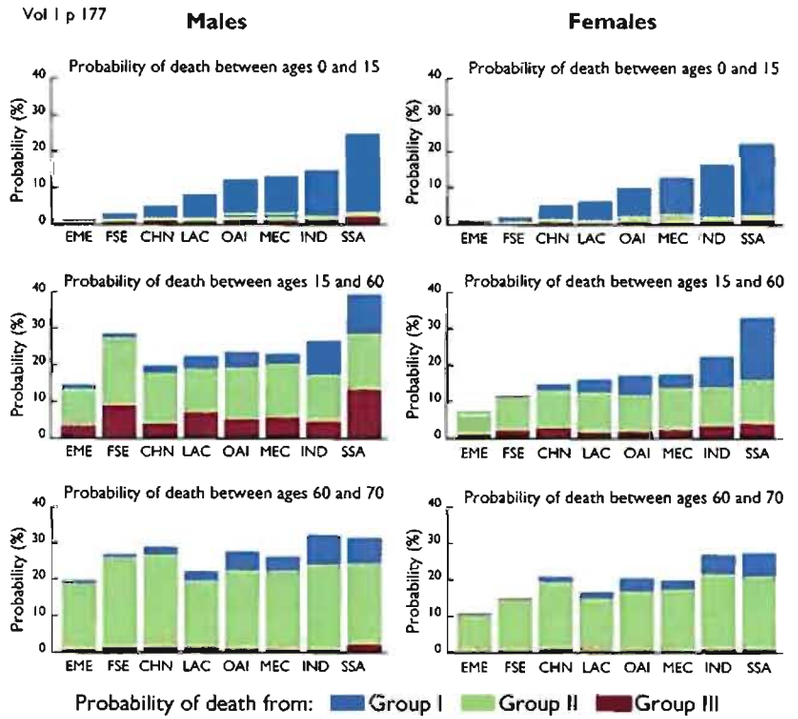
emerges. For adults under the age of 70, the probability of dying from a noncommunicable disease is greater in both Sub-Saharan Africa and India than in the Established Market Economies. The results show that premature mortality rates from noncommunicable diseases are higher in populations with high mortality and low income than in the industrialized countries (Figure 9).

The health of men in the Formerly Socialist Economies of Europe is surprisingly poor. Men face a 28 per cent risk of death between the ages of 15 and 60, the highest risk in any region except Sub-Saharan Africa. This excess is explained by a higher rate of noncommunicable diseases and also by a higher risk of death from injury than for men in the Established Market Economies.

Leading Causes of Death in 1990

Just over 50 million people died worldwide in 1990, with ischaemic heart disease (IHD) causing more deaths than any other disease or injury. Only 2.7 million of the 6.3 million who died of IHD were in the developed

Figure 9 Noncommunicable diseases are not diseases of affluence: risks of death from each broad cause Group, by region, 1990



world. Cerebrovascular disease (stroke) killed 4.4 million people, of whom only 1.4 million were in the developed world. Lower respiratory infections (pneumonia) killed 4.3 million people, all but 0.4 million of them in the developing world. Diarrhoeal diseases caused 2.9 million deaths, virtually all in the developing world. The ten leading causes together accounted for just over half of all deaths (Table 2).

The Traditional Enemies in Developing Countries

Despite the epidemiological transition, deaths from communicable diseases, maternal and perinatal conditions and nutritional deficiencies continue to take a heavy, and largely avoidable, toll even though there have been spectacular successes in their control over the past 30 years. Fully 17.3 million deaths in 1990 were due to this group of causes, and more than 16.5 million of these were in developing regions, mainly India and Sub-Saharan Africa. Of all Group I deaths, 4 out of 10 were due to either pneumonia or diarrhoeal disease, which together accounted for more than 7 million deaths. Perinatal conditions were responsible for more than 2.4 million deaths, and tuberculosis another 2.0 million deaths. The vast majority of these deaths could have been prevented with existing interventions.

Because Group I conditions affect children disproportionately, the age structure of deaths also varies sharply between regions. A baby girl born in Sub-Saharan Africa faces a 22 per cent risk of death before age 15. In China the risk is less than 5 per cent and in the Established Market Economies the risk is just 1.1 per cent.

Table 2 The ten leading causes of death, 1990

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	Developed Regions	Deaths ('000s)	Cumulative %		Developing Regions	Deaths ('000s)	Cumulative %
	All Causes	10 912			All Causes	39 554	
1	Ischaemic heart disease	2 695	24.7	1	Lower respiratory infections	3 915	9.9
2	Cerebrovascular disease	1 427	37.8	2	Ischaemic heart disease	3 565	18.9
3	Trachea, bronchus and lung cancer	523	42.6	3	Cerebrovascular disease	2 954	26.4
4	Lower respiratory infections	385	46.1	4	Diarrhoeal diseases	2 940	33.8
5	Chronic obstructive pulmonary disease	324	49.1	5	Conditions arising during the perinatal period	2 361	38.7
6	Colon and rectum cancers	277	51.6	6	Tuberculosis	1 922	43.4
7	Stomach cancer	241	53.8	7	Chronic obstructive pulmonary disease	1 887	46.1
8	Road traffic accidents	222	55.8	8	Measles	1 058	48.7
9	Self-inflicted injuries	193	57.6	9	Malaria	856	50.9
10	Diabetes mellitus	176	59.2	10	Road traffic accidents	777	52.8

Injuries and the Burden of Suicide

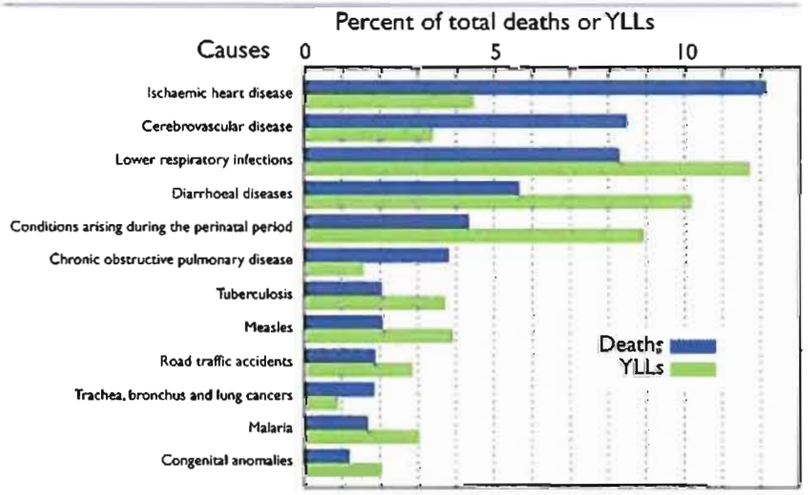
Worldwide in 1990, about 5 million people died of injuries of all types, two thirds of them men. Most of these deaths are heavily concentrated among young adults. In this age group, road traffic accidents, suicide, war, fire and violence all figured within the ten leading causes of death. The significance of injuries has been largely overlooked by the health sector in many countries.

Among adults aged 15-44 worldwide, road traffic accidents were the leading cause of death for men and the fifth most important for women. For women aged between 15 and 44, suicide was second only to tuberculosis as a cause of death. In China alone, more than 180 000 women killed themselves in 1990. In India, women face an appallingly high risk of dying in fires: in 1990 alone, more than 87 000 Indian women died this way. In Sub-Saharan Africa, by contrast, the most important cause of injury deaths for both women and men is war.

2.3 Results: The Toll of Premature Death

In contrast to crude numbers of deaths, a time-based measure such as years of life lost (YLLs, see Section 1 above) allows public health researchers to identify those causes that account for premature deaths, a more informative measure for the design of health policies. For example, injuries affect mainly young people so, while injuries accounted for only 10 per cent of deaths in 1990, they accounted for 15 per cent of YLLs. Accordingly noncommunicable diseases, which affect mainly older people, accounted for only 31 per cent of YLLs, compared with 56 per cent of deaths (Figure 10).

Figure 10 The leading causes of death and of premature death, world, 1990



3. This section summarizes Volume 1, Chapter 4, pp 201 to 246.

3. Disability: the invisible burden

3.1 How the GBD assessed disability

A disease or injury may have multiple disabling effects, or sequelae. For example, diabetes may result in diabetic foot, retinopathy, neuropathy, or amputation. To estimate the total burden of disability, the study measured the amount of time lived with each of the various disabling sequelae of diseases and injuries, in both treated and untreated states, and weighted for their severity, in each population. In all, 483 disabling sequelae of diseases and injuries were analysed for this study, for all regions and age groups, and for both sexes.

To calculate the number of years lived with a disabling condition, it is necessary to know its incidence, the average age of its onset, the average duration of the disability (whether just months or lifelong) and the severity weight for the condition. The GBD researchers requested epidemiological specialists to estimate each of these variables for each condition based on an in-depth review of published and unpublished studies. They also estimated the prevalence of each sequela, its case-fatality rates, remission rates and death rates. This information allowed them to correct the preliminary estimates for internal consistency—that is, to ensure that estimated prevalence was consistent with estimated incidence and vice versa. Consistency was validated using a model developed specially for the study, known as DisMod. Frequently, inconsistencies were detected, and epidemiological specialists were asked to revise their initial estimates. Overall, the team took the disability estimates through three complete rounds of revision in a process lasting nearly five years.

The severity weights of different conditions were set using the protocol described in Section 1. A set of 22 indicator conditions ranging from mild to severe disabilities were assigned to seven classes of severity weight between 0 (perfect health) and 1 (equivalent to death). Following this exercise, each remaining condition was assigned a distribution across these seven classes.

The number of years lived with a given disability for each individual were calculated from the incidence of the disability, with the "stream" of disability arising from it measured from the age of onset, for the estimated duration of the disability, multiplied by the condition's severity weight. To calculate the YLDs due to a condition in any given population, the number of YLDs lost per incident case must be multiplied by the number of incident cases. For example, a case of asthma carries a disability weight of 0.1 if untreated and 0.06 if treated. If the incidence of asthma in males aged 15-44 years is 1 million, the untreated proportion is 35 per cent, and the average duration is seven years, then this sequela alone is estimated to cause 664 000 YLDs in a given year for that demographic group.

Unlike the estimates of years of life lost, not all sequelae of all conditions could be explicitly assessed for YLDs. Estimates for conditions not explicitly considered were made on the basis of information on the ratio of total premature mortality (years of life lost) to disability (YLDs) for each broad cause Group.

3.2 Results: the unseen burden of psychiatric disease

The GBD's findings demonstrate clearly that disability plays a central role in determining the overall health status of a population. Yet that role has until now been almost invisible to public health. The leading causes of disability are shown to be substantially different from the leading causes of death, thus casting serious doubt on the practice of judging a population's health from its mortality statistics alone.

Mental Illnesses

Most significantly, the study shows that the burden of psychiatric conditions has been heavily underestimated. Of the ten leading causes of disability worldwide in 1990, measured in years lived with a disability, five were psychiatric conditions: unipolar depression, alcohol use, bipolar affective disorder (manic depression) schizophrenia and obsessive-compulsive disorder. Unipolar depression alone was responsible for more than one in every ten years of life lived with a disability worldwide. Altogether, psychiatric and neurological conditions accounted for 28 per cent of all YLDs, compared with 1.4 per cent of all deaths and 1.1 per cent of years of life lost. The predominance of these conditions is by no means restricted to the rich countries, although their burden is highest in the Established Market Economies. They were the most important contributor to YLDs in all regions except Sub-Saharan Africa, where they accounted for a relatively modest 16 per cent of the total.

Alcohol use is the leading cause of male disability—and the tenth largest in women—in the developed regions. More surprisingly, perhaps, it is also the fourth largest cause in men in developing regions. The remaining important causes of YLDs were anaemia, falls, road traffic accidents, chronic obstructive pulmonary disease and osteoarthritis (Table 3).

Table 3 The leading causes of disability, world, 1990

		Total (millions)	Per cent of total
	All Causes	472.7	
1	Unipolar major depression	50.8	10.7
2	Iron-deficiency anaemia	22.0	4.7
3	Falls	22.0	4.6
4	Alcohol use	15.8	3.3
5	Chronic obstructive pulmonary disease	14.7	3.1
6	Bipolar disorder	14.1	3.0
7	Congenital anomalies	13.5	2.9
8	Osteoarthritis	13.3	2.8
9	Schizophrenia	12.1	2.6
10	Obsessive-compulsive disorders	10.2	2.2

3.3 Results: longer lifespan means longer "health span" too

The GBD provides support for the theory that people in the high-income, low-mortality populations of the Established Market Economies not only live longer, but remain healthier for longer too. In recent years, researchers have been divided between those who say that ill health is "compressed" into the last few years of life in these populations, and those who argue that longer life merely exposes people to a longer period of poor health. The new results suggest that older people in the developed world are healthier than their counterparts in developing countries (Figure 11).

They found that babies born in Sub-Saharan Africa can expect to spend about 15 per cent of their lifespan disabled, compared with just 8 per cent for babies born in the Established Market Economies. A 60 year-old in Sub-Saharan Africa can expect to spend about half his or her remaining years with a disability, whereas a 60 year-old in the Established Market Economies is likely to spend just one-fifth of those years disabled. These results suggest that the proportion of the lifespan lived with a disability falls as life expectancy rises.

Figure 11 Proportion of expected remaining lifespan at age 60 that will be lived disabled, by region.

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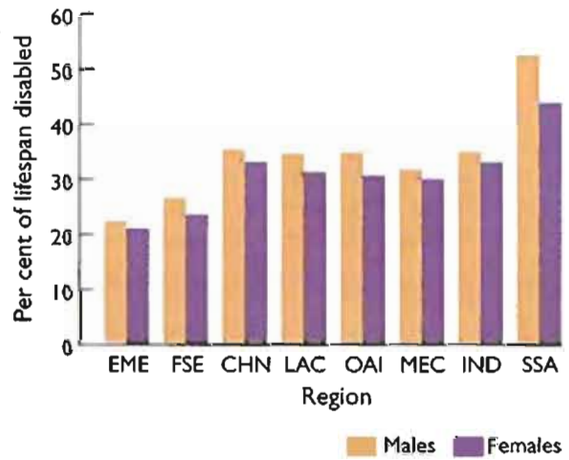

4. The Global Burden of Disease in 1990

A key aim of the GBD was to quantify the combined burden of fatal and non-fatal health outcomes in a single measure, the Disability-Adjusted Life Year (DALY). This section presents the key results of the assessments of overall burden for each region.

The methods for developing the DALY are described in section 1. To calculate DALYs due to each disease or injury in a given year and population, the researchers added together: (a) the years of life lost through all deaths in that year, and (b) the years of life expected to be lived with a disability for all cases beginning in that year summed, and weighted for the severity of the condition.

4.1 Results: Stark regional imbalances in the burden of disease

The peoples of Sub-Saharan Africa and India together bore more than four-tenths of the total global burden of disease in 1990, although they make up only 26 per cent of the world's population. By contrast, the Established Market Economies and the Formerly Socialist Economies of Europe, with about a fifth of the world's population between them, together bore less than 12 per cent of the total disease burden. China emerged as substantially the most "healthy" of the developing regions, with 15 per cent of the global disease burden and a fifth of the world's population. Put differently, about 579 years of healthy life were lost for every 1000 people in Sub-Saharan Africa, compared with just 124 for every 1000 people in the Established Market Economies. This assessment demonstrates clearly the glaring inequalities of world health at the end of the 20th century.

The rates of premature death varied sharply between regions, with rates 7 times higher in Sub-Saharan Africa than in the Established Market Economies. By contrast, the rates of disability were less varied, with Sub-Saharan Africa having twice the rate of YLDs as the rich countries (Figure 12).

Figure 12 DALYs per 1000 population by region broken down into YLL and YLD rates, 1990

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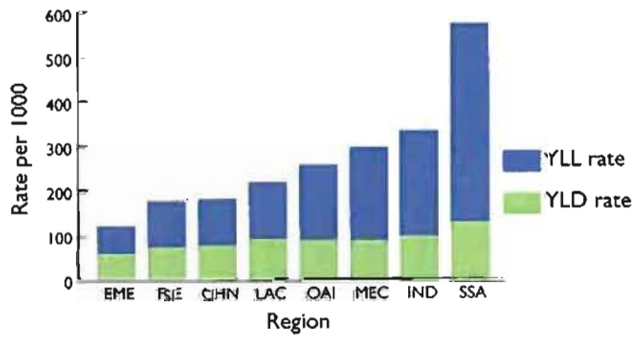

4. This section summarizes Volume 1, Chapter 5, pp 247 to 294.

Traditional Enemies Remain a Significant Force

The grip of the traditional enemies—communicable, maternal, perinatal conditions and nutritional deficiencies—persists as a problem for the whole world. Even though these Group I conditions accounted for only 7 per cent of the burden in the Established Market Economies and less than 9 per cent in the Former Socialist Economies, they nevertheless made up more than four-tenths the total global burden of disease in 1990, and almost half of the burden (49 per cent) in developing regions. In Sub-Saharan Africa, two out of three years of healthy life lost were due to Group I conditions. Even in China, where the epidemiological transition is far advanced, a quarter of years of healthy life lost were due to this Group. Worldwide, five out of the ten leading causes of disease burden are Group I conditions: lower respiratory infections (pneumonia); diarrhoeal disease; perinatal conditions; tuberculosis and measles. In developing countries, malaria is added to this already daunting list (Figure 13).

Injuries Are a Large, and Neglected, Health Problem in All Regions

The burden of injury in 1990 was highest in the Formerly Socialist Economies of Europe, where almost 19 per cent of all burden was attributed to this group of causes. China had the second highest injury burden, Latin America and the Caribbean the third, and Sub-Saharan Africa the fourth. Even in the Established Market Economies, however, the burden of injuries—dominated by road traffic accidents—was almost 12 per cent of the total.

In almost all regions, unintentional injuries were a much bigger source of ill-health in 1990 than intentional injuries such as interpersonal violence and war. The only exception was the Middle Eastern Crescent, where unintentional and intentional injuries took an approximately equal toll because of a particularly high burden of war in the region at the time.

Leading Causes of Disease Burden

When causes of death are compared, in rank order, with causes of disease burden, substantial differences emerge, again reinforcing the need to take non-fatal conditions into account as well as deaths when assessing a

Figure 13 The burden of disease, by broad cause Group, 1990

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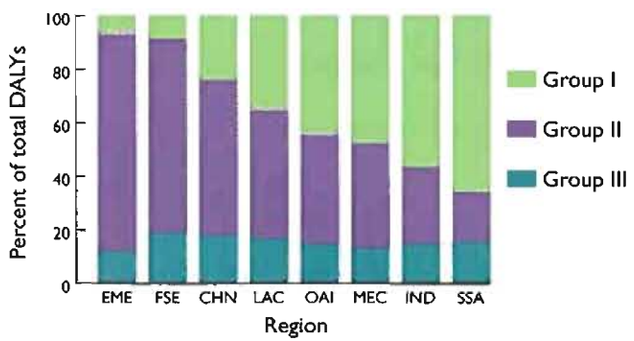

Figure 14 The relationship between the rank order of causes of global ill-health when measured using deaths alone or total disease burden, 1990

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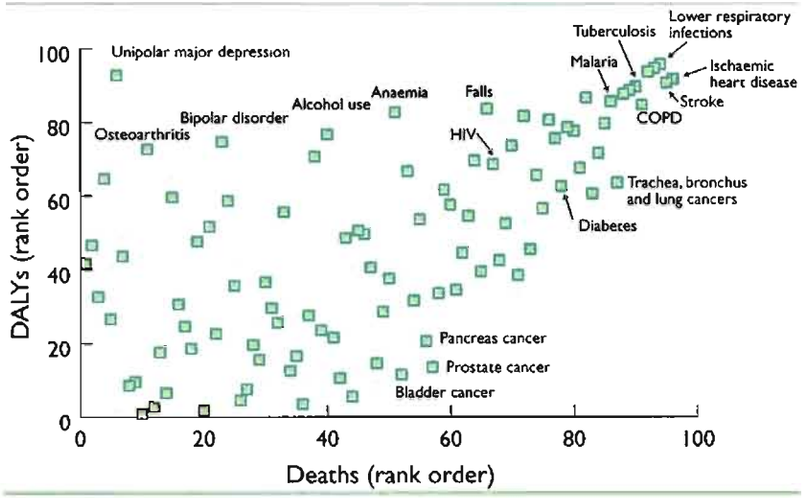


population's health status. While a few leading conditions—such as lower respiratory infections, diarrhoeal diseases and perinatal conditions—are at the top of both lists, there are 14 conditions in the top half of the list for disease burden that are in the bottom half of the list for deaths. Depression is the most marked of these, falling within the top ten for disease burden, but the bottom ten for deaths (Figure 14).

The leading causes of disease burden worldwide in 1990 were broadly similar to those for the developing regions. (Table 4).

Sex Differences in Disease Burden

Although in infancy and early childhood, girls and boys suffer from broadly similar health problems, striking sex differences emerge in adults. First, and most obviously, women suffer disproportionately from their reproductive role. Although the burden of reproductive ill-health is almost entirely confined to the developing regions, it is so great that even worldwide, maternal conditions make up three out of the ten leading causes of disease burden in women aged between 15 and 44. In developing regions, five out the ten leading causes of DALYs are related to reproductive ill-health, including the consequences of unsafe abortion and chlamydia. Almost all of this loss of healthy life is avoidable.

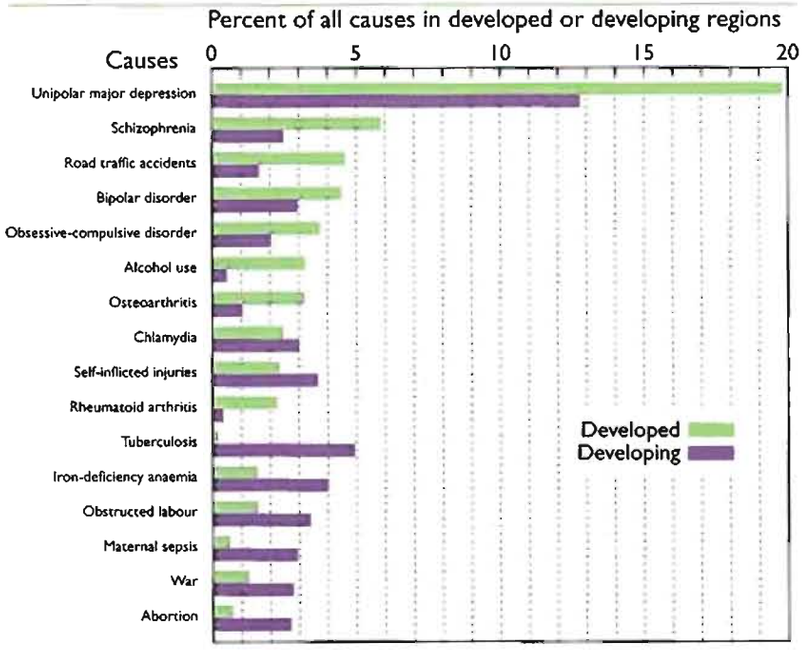
However, poor reproductive health is far from being women's sole concern (Figure 15). In both developing and developed regions, depression is women's leading cause of disease burden. In developing regions, suicide is the fourth. Thus, while programmes to reduce the unacceptably high burden of poor reproductive health must remain a high priority for years to come, women's psychological health also deserves much more attention.

Table 4 Ten leading causes of disease burden (DALYs), developing world, 1990

		Total (millions)	Per cent of total
	All Causes	1 218.2	
1	Lower respiratory infections	110.5	9.1
2	Diarrhoeal diseases	99.2	8.1
3	Conditions arising during the perinatal period	89.2	7.3
4	Unipolar major depression	41.0	3.4
5	Tuberculosis	37.9	3.1
6	Measles	36.5	3.0
7	Malaria	31.7	2.6
8	Ischaemic heart disease	30.7	2.5
9	Congenital anomalies	29.4	2.4
10	Cerebrovascular disease	29.1	2.4

For men aged 15–44, road traffic accidents are the biggest cause of ill-health and premature death worldwide, and the second biggest in developing regions, surpassed only by depression. Alcohol use, violence, tuberculosis, war, bipolar affective disorder, suicide, schizophrenia and iron-deficiency anaemia make up the remainder of the list in developing countries. The high toll of road traffic accidents in developing regions has received relatively little attention from public health specialists in the past.

Figure 15 The ten leading causes of disease burden for women, aged 15–44, 1990



5. RISK FACTORS FOR DEATH AND DISABILITY

Exposure to particular hazards, such as tobacco, alcohol, unsafe sex or poor sanitation, can significantly increase individuals' risks of developing disease. These hazards, or risk factors, are significant contributors to the total global disease burden and health policy makers need accurate information on their impact if they are to devise effective prevention strategies. Until now, however, there have been few attempts to measure the burdens of these risk factors, or to express them in a currency that can be compared directly with the burdens of individual diseases.

The GBD researchers have sought to overcome this problem. They have assessed, for the first time, the mortality and loss of healthy life that can be attributed to each of ten major risk factors in each region. These risk factors are: malnutrition; poor water supply, sanitation and personal/domestic hygiene; unsafe sex; tobacco use; alcohol use; occupation (that is, exposure to hazards through work); hypertension; physical inactivity; illicit drug use; and air pollution.

Unsafe sex was the third biggest risk factor for disease burden. In young adult women in Sub-Saharan Africa, it accounts for an estimated 30 per cent of the total burden.

5.1 HOW THE BURDEN OF RISK FACTORS WAS ASSESSED

The burden of disease or injury in a population today that can be attributed to past exposure to a given risk factor is, essentially, an estimate of the burden that could have been averted in the population if that particular risk factor had been eliminated. More precisely, this is defined as the difference between the currently observed burden and the burden that would be observed if past levels of exposure had been equal to a specified, reference distribution of exposure. In general, to calculate this, it is necessary to know: (a) the relative risk at different levels of exposure for each cause of death and disability linked to the factor; (b)the distribution of different levels of exposure in the population; and (c) the burden of disease or injury due to each of the causes linked to the factor. Depending on the nature of the risk factor, the reference distribution against which relative risk is compared could be zero exposure for the whole population, a population distribution of exposure from low to high levels based on observed populations, or an arbitrary distribution. For this study, the researchers used, wherever possible, zero exposure as the reference, except for risk factors such as hypertension, where clearly no one can be said to exposed to "zero" levels.

5. This section summarizes Volume 1, Chapter 6, pp 295 to 324.

Table 5 Global burden of disease and injury attributable to selected risk factors, 1990

Risk factor	Deaths (thousands)	As % of total deaths	YLLs (thousands)	As % of total YLLs	YLDs (thousands)	As % of total YLDs	DALYs (thousands)	As % of total DALYs
Malnutrition	5 881	11.7	199 486	22.0	20 089	4.2	219 575	15.9
Poor water supply sanitation and personal and domestic hygiene	2 668	5.3	85 520	9.4	7 872	1.7	93 392	6.8
Unsafe sex	1 095	2.2	27 602	3.0	21 100	4.5	48 702	3.5
Tobacco	3 038	6.0	26 217	2.9	9 965	2.1	36 182	2.6
Alcohol	774	1.5	19 287	2.1	28 400	6.0	47 687	3.5
Occupation	1 129	2.2	22 493	2.5	15 394	3.3	37 887	2.7
Hypertension	2 918	5.8	17 665	1.9	1 411	0.3	19 076	1.4
Physical inactivity	1 991	3.9	11 353	1.3	2 300	0.5	13 653	1.0
Illicit drugs	100	0.2	2 634	0.3	5 834	1.2	8 467	0.6
Air pollution	568	1.1	5 625	0.6	1 630	0.3	7 254	0.5

Source: Authors' estimates are based on data and information contained in individual chapters of Volume IX of the *Global Burden of Disease and Injury Series.*

5.2 Results: the contributions of risk factors to global burden

Of the ten risk factors studied, the most significant were malnutrition, poor water, sanitation and hygiene, unsafe sex, alcohol, tobacco and occupation. Together, these six hazards accounted for more than one-third of total disease burden worldwide in 1990 (see Table 5). Of the six, malnutrition and poor sanitation were the dominant hazards, responsible for almost a quarter of the global burden between them. Unsafe sex and alcohol each contributed approximately 3.5 per cent of the total disease burden, closely followed by tobacco and occupation hazards with just under 3 per cent each. These are comparable to the burdens caused by tuberculosis and measles.

Not surprisingly, the researchers found sharp inequalities between regions and between men and women in the burdens of most risk factors. For example, the ill-health consequences of unsafe sex—which include both infections and the complications of unwanted pregnancy—are borne disproportionately by women in all regions. In young adult women in Sub Saharan Africa, unsafe sex accounts for almost one-third of the total disease burden.

Tobacco and alcohol currently cause their heaviest burdens in men in the developed regions. In these regions, the two together accounted for more than one-fifth of the total burden in 1990. However, the health burdens of smoking and drinking are far from being the exclusive preserve of the industrialized world. The recent rapid increase in tobacco use in Asia and other developing regions is expected to kill many more people in the coming decades than have so far died in the developed regions (see Section 6).

Figure 16 Male deaths attributable to, and averted by, alcohol use.

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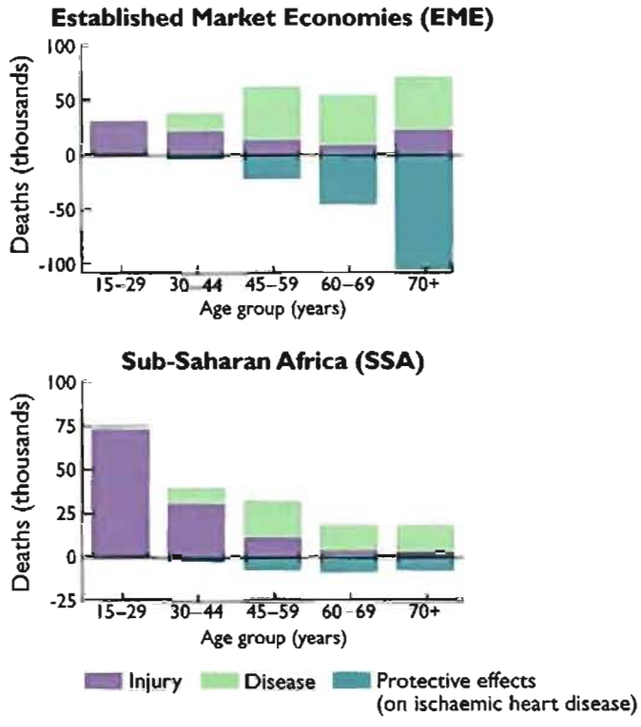


The impact of alcohol varies between regions not only because of different levels of use in each population, but also because of differences in the age structure of those populations (Figure 16). Alcohol has consistently been shown to provide some protection against death from ischaemic heart disease, but to increase the risk of several other diseases, such as alcoholic psychoses, pancreatitis, some cancers and cirrhosis of the liver, as well as many injuries. Because of its protective effect against ischaemic heart disease, in populations where this condition is common and injuries and violence are rare, alcohol may prevent about as many deaths as it causes. In the Established Market Economies, for instance, this is probably the case. Nevertheless, alcohol causes a severe disease burden in these rich countries, because it causes so many injuries and premature deaths and thus results in large numbers of years lived with a disability and years of life lost.

In Sub-Saharan Africa, the picture is very different. There, ischaemic heart disease is relatively uncommon, so the protective effect of alcohol is far outweighed by its harmful effects in increasing the rates of death and disability from injuries. The contribution of alcohol to injuries is also

extremely high in Latin America and the Caribbean, where alcohol use accounts for almost 10 per cent of total disease and injury burden, a figure surpassed only in the developed regions. Ultimately, alcohol is estimated to have caused about three-quarters of a million more deaths in 1990 than it averted, with more than four-fifths of the excess deaths in the developing regions.

5.3 Some diseases are themselves powerful risk factors for other diseases

While assessments of the burdens of risk factors such as tobacco and alcohol can help to guide priorities, it is also useful to think about the impact of certain diseases as risk factors for other diseases. For example, diabetes mellitus strongly increases an individual's risk of developing ischaemic heart disease and stroke, while infection with hepatitis B virus increases the risk of developing liver cancer and cirrhosis of the liver. Traditional methods of assessing deaths by cause fail to capture these relationships. The GBD researchers have attempted to overcome this for a short list of well-studied conditons. They treated each condition as a risk factor and estimated how much of the total disease burden would be averted in each region's population if the condition were eliminated (Table 6). The most dramatic differences between directly coded and total burden are for diabetes and hepatitis B and hepatitis C.

Table 6. Total burden for major diseases, world, 1990

	Deaths			
	Both sexes (thousands)	Males (thousands)	Females (thousands)	Direct/ total
Chagas disease	49.2	28.0	21.2	0.39
Hepatitis B and hepatitis C	818.7	559.6	259.1	0.13
Diabetes mellitus	2 758.9	1 279.4	1 479.6	0.21
Cataracts	1 104.4	544.0	560.4	0.01
Glaucoma	330.5	141.4	189.1	0.02
Onchocerciasis	18.6	11.8	6.8	0 00
Trachoma	103.1	29.4	73.7	0.00
Unipolar major depression	786.2	456.4	329.9	0.00
Sexually transmitted diseases	413.3	183.0	230.3	0.56
	DALYs			
	Both sexes (millions)	Males (millions)	Females (millions)	Direct/ total
Chagas disease	1.6	0.9	0.7	0.40
Hepatitis B and hepatitis C	13.3	9.2	4.1	0.16
Diabetes mellitus	26.3	12.9	13.4	0.42
Cataracts	17.9	8.6	9.2	0.42
Glaucoma	5.8	2.3	3.5	0.44
Onchocerciasis	1.2	0.7	0.5	0.76
Trachoma	2.0	0.6	1.4	0.51
Unipolar major depression	69.8	28.3	41.5	0.73
Sexually transmitted diseases	25.3	9.1	16.2	0.74

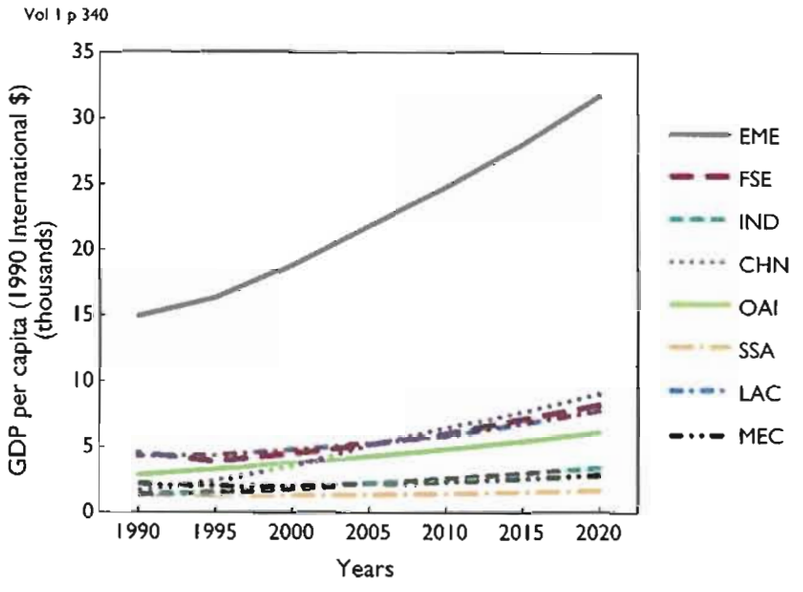
6. Looking ahead: the health of the world in 2020

To plan health services effectively, policy-makers need to know how current health needs could develop in the future. For this study, the GBD developed projections of mortality and disability for each five year period from 1990 to 2020, by cause, for all regions and both sexes. The findings have striking implications for public policy.

6.1 How the projections were developed

The GBD researchers used a set of relatively simple models to develop projections of future health trends. Rather than attempt to model the effects of the many separate direct, or proximal, determinants of disease from the limited data that are available, it was decided to consider a limited number of socio-economic variables: (1) income per capita; (2) the average number of years of schooling in adults, termed "human capital"; and (3) time, a proxy measure for the secular improvement in health this century that results in part from accumulating knowledge and technological development. These socio-economic variables show clear historical relationships with mortality rates: for example, income growth is closely related to the improvement in life expectancy that many countries have

Figure 17 The rich get richer: baseline projections of income per capita by region, 1990-2020



6. This section summarizes Volume 1, Chapter 7, pp 325 to 395.

achieved this century. Because of their relationships with death rates, these socioeconomic variables may be regarded as indirect, or distal, determinants of health. In addition, a fourth variable, tobacco use, was included, because of its overwhelming impact on health status, using information from more than four decades of research on the time lag between persistent tobacco use—measured in terms of "smoking intensity"— and its effects on health.

Death rates for all major causes based on historical data for 47 countries since 1950–91 were related to these four variables to generate the projections. A separate model was used for HIV and modifications for the interaction between HIV and tuberculosis. Three projection scenarios were developed using different projections of the independent variables.

6.2 Results: patterns of death—and life—in the 21st century

Life Expectancy Grows Almost Everywhere, but Men Fare Worse

Life expectancy at birth is expected to grow for women in all regions. By 2020, infant girls born in the Established Market Economies may expect to survive to almost 88 years (Figure 18). For men, life expectancy will grow much more slowly, mainly because of the impact of the tobacco epidemic. Nevertheless by 2020, males born in Sub-Saharan Africa, whose life expectancy at birth was below 50 in 1990, may expect to reach 58 years. Males born in Latin America and the Caribbean, who in 1990 could have expected to live to 65, may expect to reach 71 years.

However, for men in the Formerly Socialist Economies of Europe, life expectancy is not expected to grow at all between 1990 and 2020. This is partly due to the fact that it has actually fallen between 1990 and 1995, so that any positive change is likely to be merely recovering to the 1990 position.

In young children and adolescents under the age of 15, the risk of death is projected to decline dramatically in all regions, falling by about two-thirds in Sub-Saharan Africa and India. In adult women, too, the risk of death is expected to fall in all regions. For men, the picture is more complex. Because of the tobacco epidemic, men in the Formerly Socialist Economies of Europe and China may expect a higher risk of dying between the ages of 15 and 60 than they do today. In other regions, the risk of death for men in this age group is expected to fall, but more modestly than in women. Remarkably, by 2020, men of this age group in the Formerly Socialist Economies of Europe could face a higher risk of death even than men in Sub-Saharan Africa.

The Impact of Infectious Disease May Be Reduced

Deaths from communicable, maternal and perinatal conditions and nutritional deficiencies (Group I) are expected to fall from 17.3 million in 1990 to 10.3 million in 2020. As a percentage of the total burden, Group I conditions are expected to drop by more than half, from 34 per cent to 15 per cent.

Figure 18 Projected life expectancy at birth in 2020, by region: baseline, optimistic and pessimistic scenarios, compared with 1990 estimates

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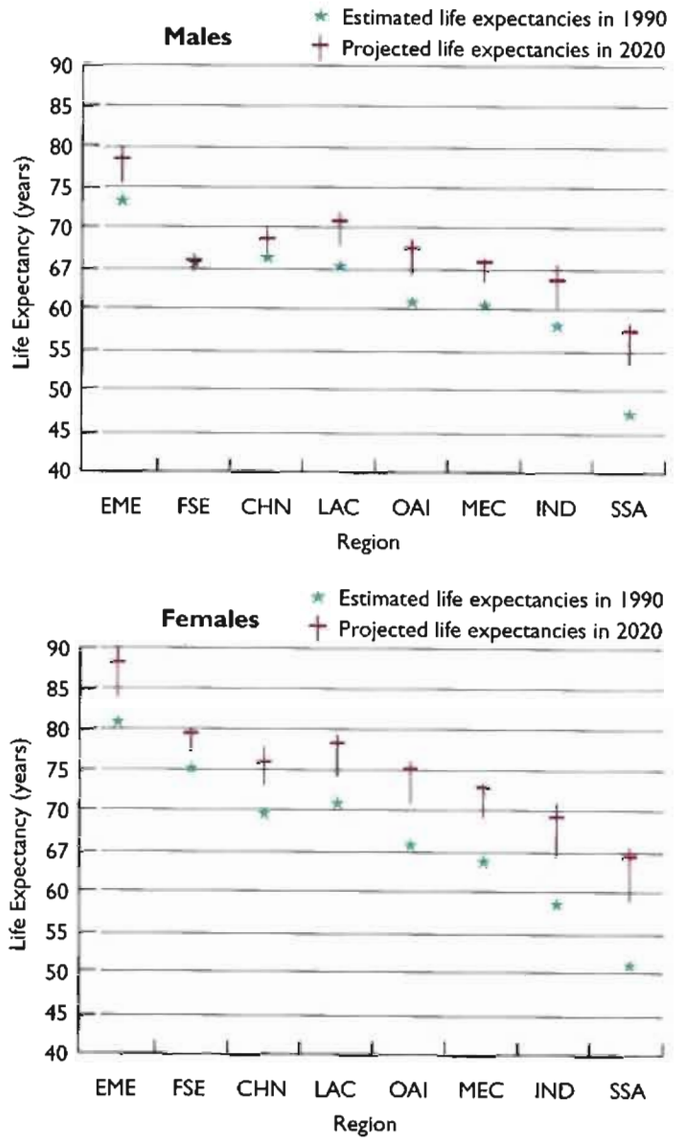

Note: The stars in the figure denote life expectancies at birth in 1990. Baseline life expectancies projected for 2020 appear as a horizontal bar crossed by a vertical bar that gives upper and lower limits defined by the optimistic and pessimistic projection scenarios.

This projected reduction overall, despite increased burdens due to HIV and tuberculosis, runs counter to the now widely-accepted belief that infectious diseases are making a comeback worldwide. It reflects, in part, the *relative* contraction of the world's "young" population: the under-15 age group is expected to grow by only 22 per cent between 1990 and 2020, whereas the cohort of adults aged between 15 and 60 is expected to grow by more than 55 per cent. In addition, the projection reflects the observed overall decline in Group I conditions over the past four decades, due to increased income, education and technological progress in the development of antimicrobials and vaccines. Even under the pessimistic scenario, in which both income growth and technological progress are expected to be minimal, deaths from these conditions are still expected to fall slightly to 16.9 million (Figure 19).

Even under the pessimistic scenario, deaths from infectious diseases, maternal and perinatal conditions and nutritional deficiencies are expected to fall slightly.

Clearly, it should not be taken for granted that the progress of the past four decades against infectious diseases will be maintained. It is possible, for example, that antibiotic development and other control technologies

Figure 19 Pessimistic projection of deaths from Group I causes, world, 1990–2020

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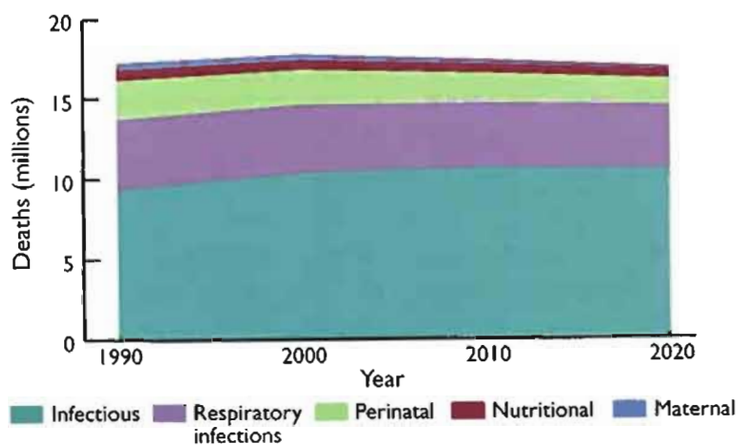


will not keep pace with the emergence of drug-resistant strains of important microbes such as *Mycobacterium tuberculosis*. If such a frightening scenario were to prove correct, and if, in addition, case-fatality rates were to rise because of such drug-resistant strains, the gains of the present century could be halted or even reversed. Undoubtedly, the continuing high toll of Group I causes today leaves no room for complacency. Nonetheless, the evidence to date suggests that, as long as, and only if, current efforts are maintained, Group I causes are likely to continue to decline.

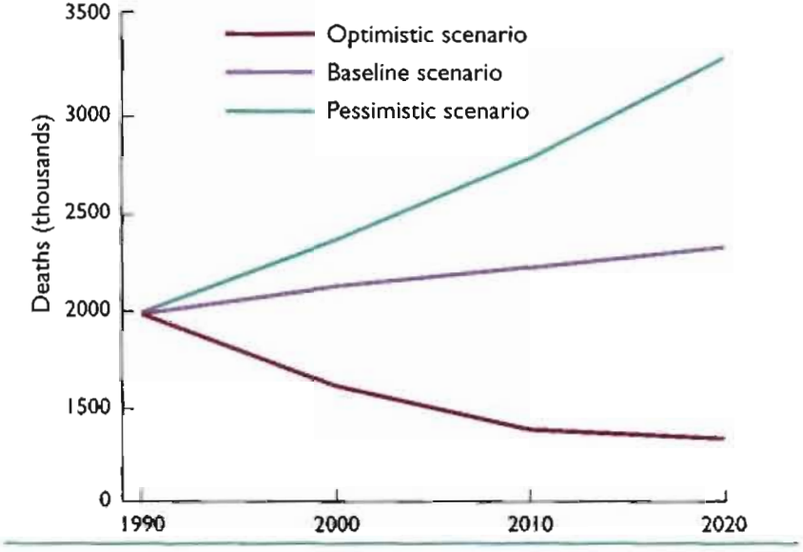
HIV and Tuberculosis

Projections for HIV mortality were developed using a separate model. The GBD projections for HIV demonstrate that the death toll from the AIDS epidemic may be even greater than feared in future.

In Sub-Saharan Africa, death rates from HIV/AIDS are expected to peak around 2005 with around 800 000 deaths per year. In India, death rates are expected to peak a little later, around 2010, at about half a million a year. The worldwide peak for HIV deaths is expected to be around 2006, with perhaps 1.7 million deaths that year. Clearly, these estimates are subject to considerable uncertainty.

Projections of the future impact of tuberculosis are also subject to large uncertainties, but the results are no more reassuring than those for AIDS. The figure shows baseline, optimistic and pessimistic projections of the deaths the disease is expected to cause between 1990 and 2020 (Figure 20).

Figure 20 Projections of deaths from tuberculosis, world, 1990–2020



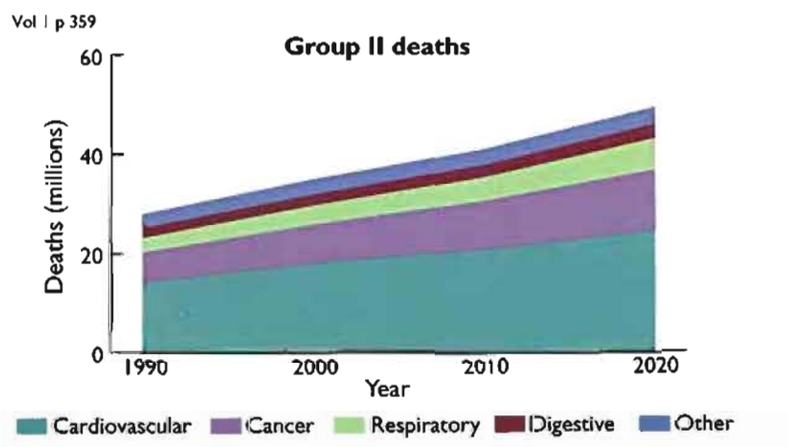
The Rise of Noncommunicable Diseases

While overall, Group I conditions are expected to decline, deaths from noncommunicable diseases (Group II) are expected to climb from 28.1 million deaths in 1990 to 49.7 million in 2020, an increase of 77 per cent in absolute numbers. In proportionate terms, Group II deaths are expected to increase their share of the total from 55 per cent in 990 to 73 per cent in 2020. These global figures, impressive as they are, mask the extreme nature of the change that is projected in some developing regions because they incorporate the projections for the rich nations, which show little change. In India, deaths from noncommunicable diseases are projected to almost double, from about 4 million to about 8 million a year, while Group I deaths are expected to fall from almost 5 million to below 3 million a year. In the developing world as a whole, deaths from noncommunicable diseases are expected to rise from 47 per cent of the burden to almost 70 per cent.

The steep projected increase in the burden of noncommunicable diseases worldwide is largely driven by population aging, augmented by the large numbers of people in developing regions who are now exposed to tobacco. It is important to stress that aging will result in a rise in the absolute numbers of cases of noncommunicable diseases and in their increased share of the total disease burden for the population as a whole, but not in any change to the rates of those diseases *in any given age group*.

As studies in the Established Market Economies show, the age-specific rates of some important noncommunicable diseases, such as ischaemic heart disease and stroke, have been falling steadily for at least two decades. Whether these rates are also falling in other regions is much less clear.

Figure 21 The rise of noncommunicable diseases: Group II deaths by causes, world, 1990–2020



However, any age-specific decrease in the rates of these diseases that may also emerge in low-income countries is likely to be outweighed by the large and demographically driven increase in the *absolute numbers* of adults at risk for these diseases, augmented by the tobacco epidemic.

As with noncommunicable diseases, deaths from injury are also expected to rise for mainly demographic reasons. Young adults are generally exposed to greater risks of injury.

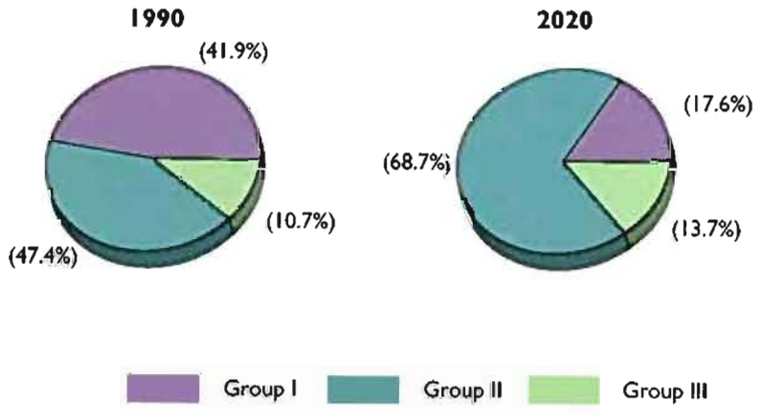
6.2 The burden of disease in 2020

When disability is taken into account as well as death, a different view of the future emerges — and one that emphasizes adult health problems still further. By 2020, the disease burden due to communicable, maternal and perinatal conditions and nutritional deficiencies (Group I) is expected to fall to a fifth of the total. The burden attributable to Group II, accordingly, is expected to rise sharply, and the burden from injuries is also expected to rise to that of Group I conditions (Figure 22).

Mental Health: Unmet and Growing Needs

As with the 1990 assessments, psychiatric diseases emerge as a highly significant component of global disease burden when disability, as well as death, is taken into account. The projections show that psychiatric and neurological conditions could increase their share of the total global burden by almost half, from 10.5 per cent of the total burden to almost 15 per cent in 2020. This is a bigger proportionate increase than that for cardiovascular diseases.

Figure 22 Change in the distribution of DALYS, by broad cause Group, developing regions, 1990–2020.



Tobacco's Legacy

By 2020, the burden of disease attributable to tobacco is expected to outweigh that caused by any single disease. From its 1990 level of 2.6 per cent of all disease burden worldwide, tobacco is expected to increase its share to just under 9 per cent of the total burden in 2020, compared with just under 6 per cent for ischaemic heart disease, the leading projected disease. This is a global health emergency that many governments have yet to confront.

Leading Causes of Disease Burden in 2020

Figure 2 on page 8 shows how the global pattern of disease burden is expected to shift over the next 24 years. In 1990, the three leading causes of disease burden were, in descending order, pneumonia, diarrhoeal diseases and perinatal conditions. The three conditions projected to take their place by 2020 are ischaemic heart disease, depression and road traffic accidents. Pneumonia is expected to fall to sixth place, diarrhoeal diseases to ninth and perinatal conditions to eleventh. Notably, measles, currently in eighth place, is expected to drop to twenty-fifth. However, not all infectious diseases are expected to decline, despite the projected overall collapse of Group I conditions. Tuberculosis is expected to remain at its current level of seventh place, a substantial source of disease burden for the foreseeable future. Of equally great concern is the finding that HIV, currently twenty-eighth in the ranking, could be as high as tenth by 2020.

Road Traffic Accidents and Violence

Because of the growth of the adult fraction of the population, the burdens of several important types of injury are also likely to increase. For example, young men are the group most frequently involved in road traffic accidents, so if the young-adult proportion of the population increases sharply, road traffic accidents are likely to increase too. Indeed, according to the baseline projection, road traffic accidents could rise to third place from ninth worldwide. Violence, currently nineteenth, could rise as high as twelfth place and suicide could climb from seventeenth to fourteenth place.

Not surprisingly, these changes are not expected to be evenly dispersed worldwide. The total number of lost years of healthy life in the Established Market Economies is likely to fall slightly, while it will increase slightly in the Formerly Socialist Economies of Europe. Strikingly, however, Sub-Saharan Africa's future looks disturbingly poor *despite* the decline in the burden of Group I conditions that currently dominate its health needs. Overall, the region faces an increase in the number of lost years of healthy life between 1990 and 2020, due mainly to a steep projected rise in the burden of injuries from road accidents, war and violence.

Conclusion

The GBD study has provided a new and much needed picture of current and projected health needs. In particular, it has shown that noncommunicable diseases are rapidly becoming the dominant causes of ill-health in all developing regions except Sub-Saharan Africa; it has revealed the extent to which mental health problems have been underestimated worldwide; and it has shown the significance of injuries as a problem for the health sector in all regions. The findings pose new and immediate challenges to policy-makers and are certain to provoke debate. Ultimately, the study's impact will be judged in two ways: first, by the degree to which it stimulates other researchers to apply the same rigorous methods of measuring disease burden in all regions; and second, to the extent that it changes priorities for public health in the decades ahead.

From the Series

Talbe of Contents: *The Global Burden of Disease*

Annex Tables to *The Global Burden of Disease*

GLOBAL HEALTH STATISTICS *provides these detailed epidemiological estimates for 240 conditions. The following are examples of these tables:*

Table 158 **Cuadro 158** **Tableau 158**
Diabetes Mellitus **Diabetes mellitus** **Diabète sucré**

Cases — Casos — Cas

Table 158a **EME - PEMC - EMBE** Diabetes mellitus - Cases

Age group (years)	Incidence 1990 Number ('000s)	Incidence 1990 Rate (per 100 000)	Prevalence 1990 Number ('000s)	Prevalence 1990 Rate (per 100 000)	Avg. age at onset (years)	Average duration (years)	Deaths 1990 Number ('000s)	Deaths 1990 Rate (per 100 000)	Deaths 2000 (Projected) Number ('000s)	Deaths 2000 (Projected) Rate (per 100 000)
Males										
0-4	3	11.0	7	27	2.5	63.6	0	0.1	0	0.1
5-14	4	8.0	50	94	10.0	57.5	0	0.0	0	0.0
15-44	113	61.6	1 900	1 032	30.0	39.5	3	1.4	2	1.3
45-59	408	616.9	4 240	6 411	52.3	20.6	7	11.0	7	9.2
60+	567	936.4	10 573	17 463	70.7	9.0	47	77.9	53	73.3
All ages	1 096	280.6	16 771	4 295	59.2	16.8	57	14.6	63	15.2
Females										
0-4	3	10.0	6	25	2.5	69.6	0	0.1	0	0.1
5-14	6	11.0	53	104	10.0	63.8	0	0.1	0	0.1
15-44	109	60.8	1 898	1 059	29.9	45.2	2	0.9	1	0.7
45-59	404	595.9	4 332	6 389	52.3	24.9	5	7.5	5	5.7
60+	692	818.0	14 790	17 490	72.4	10.2	81	96.1	96	98.3
All ages	1 213	297.7	21 079	5 175	61.5	18.6	88	21.6	102	23.7
Total	2 308	289.3	37 850	4 744	60.4	17.8	145	18.2	164	19.6

Table 158c **India - Inde - Inde** Diabetes mellitus - Cases

Age group (years)	Incidence 1990 Number ('000s)	Incidence 1990 Rate (per 100 000)	Prevalence 1990 Number ('000s)	Prevalence 1990 Rate (per 100 000)	Avg. age at onset (years)	Average duration (years)	Deaths 1990 Number ('000s)	Deaths 1990 Rate (per 100 000)	Deaths 2000 (Projected) Number ('000s)	Deaths 2000 (Projected) Rate (per 100 000)
Males										
0-4	4	7.0	3	5.6	2.5	0.97	2	3.5	2	3.8
5-14	7	7.0	7	7.0	10.0	5.27	4	4.3	3	2.8
15-44	96	47.7	1 364	680.4	29.7	32.88	5	2.3	4	1.8
45-59	345	725.2	3 068	6 448.9	52.2	16.89	10	20.9	10	16.4
60+	283	949.2	4 795	16 109.5	69.1	7.35	28	94.5	29	77.6
All ages	734	167.1	9 238	2 102.4	55.1	15.11	49	11.2	48	9.4
Females										
0-4	4	7.0	3	5.6	2.5	0.97	2	3.6	2	4.0
5-14	7	7.0	7	7.0	10.0	5.26	4	4.4	3	2.8
15-44	87	47.7	1 236	674.7	29.7	34.08	4	2.2	3	1.4
45-59	329	714.1	2 956	6 425.8	52.2	17.93	11	23.3	10	17.4
60+	272	941.3	4 645	16 058.5	69.5	7.49	34	116.2	39	101.4
All ages	699	170.4	8 847	2 157.2	55.4	15.66	55	13.3	58	12.0
Total	1 433	168.7	18 085	2 128.9	55.3	15.38	104	12.2	106	10.6

Table 158f **SSA - ASS - ASS** Diabetes mellitus - Cases

Age group (years)	Incidence 1990 Number ('000s)	Incidence 1990 Rate (per 100 000)	Prevalence 1990 Number ('000s)	Prevalence 1990 Rate (per 100 000)	Avg. age at onset (years)	Average duration (years)	Deaths 1990 Number ('000s)	Deaths 1990 Rate (per 100 000)	Deaths 2000 (Projected) Number ('000s)	Deaths 2000 (Projected) Rate (per 100 000)
Males										
0-4	1	2.0	1	1.1	2.4	0.61	0	0.8	*1*	*0.8*
5-14	1	2.0	1	1.3	10.0	2.95	1	2.0	*1*	*1.4*
15-44	22	20.9	300	289.5	29.4	29.54	1	0.9	*1*	*0.7*
45-59	77	377.7	646	3 179.1	52.1	15.65	2	10.4	*2*	*8.0*
60+	54	514.1	874	8 320.9	69.0	7.10	5	49.2	*6*	*39.3*
All ages	155	61.4	1 822	722.0	54.1	14.41	10	4.0	*11*	*3.1*
Females										
0-4	1	2.0	1	1.1	2.4	0.61	0	1.0	*1*	*1.0*
5-14	1	2.0	1	1.3	10.0	2.99	1	2.0	*1*	*1.4*
15-44	22	20.9	307	288.7	29.5	30.66	0	0.4	*0*	*0.3*
45-59	82	372.9	700	3 162.9	52.2	16.40	3	11.8	*2*	*8.4*
60+	73	572.6	1 099	8 635.4	69.4	7.25	8	65.7	*9*	*52.2*
All ages	180	69.8	2 107	816.8	55.8	14.27	13	5.2	*14*	*4.0*
Total	335	65.8	3 929	769.9	55.0	14.33	23	4.6	*24*	*3.5*

For epidemiological sources see McKeigue and King 1996. For the methods used to estimate and project incidence, prevalence, and deaths see Murray and Lopez 1996a. See explanatory notes for definitions and caveats.

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