Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Defining Statement
The Global Burden of Disease Study
The Global Burden of Infectious Diseases: Main Findings

Policy Implications
Further Reading

Glossary

disability-adjusted life year (DALY) The measurement unit that was developed for the Global Burden of Disease Study. The DALY is a time-based measure, and thus a form of QALY, in which the value choices have been standardized. The DALY is one lost year of healthy life. It captures in a single indicator the impact of both premature death and nonfatal health outcomes of diseases and injuries. DALYs from a condition are the sum of years lost to premature death and years lived with a disability adjusted for the severity of the disability. The DALY incorporates explicit and transparent value choices for the duration of life lost, the value of life lived at different ages, comparison time lived with a disability with time lost due to mortality, and time preference. It is built on the principle that only two characteristics of individuals that are not directly related to their health – their age and sex – should be taken into consideration when calculating the burden of a given health outcome in that individual, whereas socioeconomic status, race, and education are not considered. Time lived with a disability and time lost to premature death are age weighted to reflect the greater social role played by adults in caring and providing for the young and the old. Time has been discounted at 3% so that a year lost in the future is less valuable than a year lost today. The use of nonuniform age weights that give less weight to years lived at younger and older ages has been the most contentious social value incorporated in the GBD 1990, and has been dropped in the revised estimates of the global burden of disease for 2001, which applies uniform age weights (DALY 3.0).

quality-adjusted life year (QALY) A time-based measure that incorporates judgments about the value of time spent in different health states. 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. The term QALY does not imply any specific value choices or methods used to elicit preferences for health states. A range of such time-based measures have been developed in different countries.

years lived with a disability (YLD) Years lived with a disability of known severity and duration. Although death is clearly defined, disability is not. It is difficult to define because nonfatal health outcomes differ from each other in their causes, name, nature, impact on the individual, and the way in which the surrounding community responds. To compare different disabilities, time lived with various short-, medium-, and long-term disabilities is weighed by a severity weight that is based on the measurement of social value preferences for time lived in various health states. Severity weights range from 0 (perfect health) to 1 (equivalent to death). Two methods were used to formalize social preferences for different states of health. Both ask people to make trade-offs between quantity and quality of life. Results of time trade-off exercises showed a surprisingly wide agreement between cultures on what constitutes a severe or mild disability. For example, a year lived with blindness appears to most people as more severe than a year lived with watery diarrhea but less severe than a year lived with quadriplegia.

years of life lost (YLL) A year lost due to premature death, defined as a death occurring before the age to which the person could have expected to survive if he or she were a member of a standardized model population with a life expectancy at birth equal to one of the world’s longest surviving populations (Japan), or 82.5 years for female and 80 years for males.
Defining Statement

Systematic efforts to quantify and monitor the burden of specific health conditions in populations, at the national level, started in the mid-1950s for malaria, poliomyelitis, and influenza in the United States. Comprehensive surveillance of morbidity and mortality for dozens of conditions has since been well established in the United States and in other industrialized countries. However, despite the clear need for epidemiological data to inform health policies, reliable and comprehensive health statistics are not available in many developing countries. International efforts to assess and monitor the burden of certain diseases have been limited in the past to a small number of infectious diseases in the context of global eradication programs—smallpox, poliomyelitis, guinea worm, and, more recently, HIV/AIDS, severe acute respiratory syndrome (SARS), and avian flu influenza A (H5N1).

The Global Burden of Disease Study (GBD), published in 1996, filled an important gap in our knowledge of population health status. It created a common metric, the disability-adjusted life year (DALY), to estimate morbidity and mortality for eight regions that collectively span the world's population, generating comparable information on incidence and prevalence in global health. However, patterns of disease, disability, and risk factors have since changed significantly and new data on their distribution are available. Furthermore, the unprecedented money and attention now pouring into international health has made an accurate assessment of global health patterns a matter of utmost urgency. The new Global Burden of Diseases, Injuries, and Risk Factors (GBD 2005) project, which began in 2007, represents the first major effort at a systematic revision of estimates in health for every region in the world comprehensively, and will ensure that that the global health community bases its research and policies on complete, valid, and reliable information. Burden of disease estimates provided in this article are for 2001—the year for which the most recent estimates of the global burden of disease and risk factors are currently available.

Causes of deaths were categorized into three main groups: group I (infectious diseases and maternal, perinatal, and nutritional conditions), group II (noncommunicable diseases), and group III (injuries). Accordingly, estimates of the global burden of infectious diseases are provided in the context of the overall burden from other conditions, diseases, and injuries. The relative importance of the burden of infectious diseases was forecasted to change by 2020. As the epidemiological transition progresses worldwide, a decline in the burden of infectious diseases is expected as the burden of noncommunicable diseases and injuries gradually increases. The pace of the epidemiological transition, however, varies greatly among regions so that the projected decreases in the burden of infectious diseases are expected to vary between regions. Trends in the global burden due to specific infectious diseases projected to 2020 also vary among specific conditions. The global burden of HIV/AIDS, for instance, is expected to greatly increase, whereas the global burden due to respiratory infections and diarrheal diseases is expected to decrease. Contrary to expectations, the global burden of malaria has increased in recent years.

The Global Burden of Disease Study

Objectives

The GBD had three main objectives. The first objective was to add information about nonfatal health outcomes to debates of national and international health policy. International data sets that are based on similar diagnostic and reporting procedures are almost exclusively focused on mortality and fail to incorporate comparable information on nonfatal health outcomes. As a result, nonfatal health outcomes have been for the most part neglected in the international health policy debate.

The second objective was to produce objective, independent, and demographically plausible epidemiological assessments of health status in order to decouple epidemiology from advocacy. Estimates of the numbers killed or affected by particular conditions or diseases may be exaggerated beyond demographically plausible limits by well-intentioned epidemiologists who also act as advocates for the affected populations in competition for scarce resources.

The third objective was to provide an outcome measure for cost-effectiveness analyses of interventions that could reduce the burden of either proximal biological causes or the more distal risk factors and socioeconomic determinants, in terms of cost per unit of burden averted.
GBD Regions

The GBD 1990 provided internally consistent estimates of deaths, years of life lost (YLLs), years lived with a disability (YLDs), and DALYs for 107 causes of deaths disaggregated by age and sex for the world and eight regions in 1990 and projected to 2020. The criteria used to define these regions included the level of socioeconomic development, epidemiological homogeneity, and geographic contiguity. Estimates for 2001 were made for high-income countries and low- and middle-income countries (LMICs), which comprise five regions – East Asia and the Pacific, Europe and Central Asia, Latin America and the Caribbean, Middle East and North Africa, South Asia, and sub-Saharan Africa.

GBD Classification System for Diseases and Injuries

The selection of the classification scheme to represent mortality by cause for the GBD was driven by the intent to provide information that would be useful for the health policy debate. The challenge was to strike the proper balance between too little and too much detail in the selection of the final list of causes. At the simplest end of the spectrum, cause of death can be aggregated in just three categories: infectious and parasitic diseases, chronic diseases, and injuries. This level of aggregation, however, would not be useful to inform the choice of specific health priorities or to assess the potential to improve survival through specific intervention strategies. At the other end of the spectrum, an overly detailed list of causes would make cross-national and intertemporal comparisons difficult to interpret. Accordingly, the classification adopted follows a tree structure of causes of death. At the first level of disaggregation, overall mortality was divided into three broad groups: group I (infectious diseases and maternal, perinatal, and nutritional conditions), group II (noncommunicable diseases), and group III (injuries). Each group was further subdivided into several major subcategories. All infectious diseases were included under the first two major subcategories of group I: infectious and parasitic diseases (IA) and respiratory infections (IB). Other group I subcategories are maternal conditions (IC), perinatal conditions (ID), and nutritional conditions (IE). Group II was subdivided into 14 subcategories — e.g., cancers, cardiovascular diseases, and neuropsychiatric conditions. Group III was subdivided into two categories — intentional injuries and nonintentional injuries. Each second-level category was further disaggregated into two levels that include a total of 107 individual causes, such as HIV, lung cancer, or motor-vehicle accidents. Table 1 provides the detailed classification used in the GBD for infectious diseases.

Table 1 Global Burden of Disease Study Classification System for Diseases and Injuries: Group I – communicable, maternal, perinatal, and nutritional conditions

| Title of GBD cause                                      |
|--------------------------------------------------------|
| Communicable, maternal, perinatal, and nutritional conditions |
| A. Infectious and parasitic diseases                   |
| 1. Tuberculosis                                        |
| 2. Sexually transmitted diseases, excluding HIV        |
| 2a. Syphilis                                           |
| 2b. Chlamydia                                          |
| 2c. Gonorrhea                                          |
| 3. HIV/AIDS                                            |
| 4. Diarrheal diseases                                  |
| 5. Childhood cluster diseases                          |
| 5a. Pertussis                                          |
| 5b. Poliomyelitis                                      |
| 5c. Diphtheria                                         |
| 5d. Measles                                            |
| 5e. Tetanus                                            |
| 6. Bacterial meningitis and meningococcemia            |
| 7. Hepatitis B and hepatitis C                          |
| 8. Malaria                                             |
| 9. Tropical-cluster causes                             |
| 9a. Trypanosomiasis                                    |
| 9b. Chagas’ disease                                    |
| 9c. Schistosomiasis                                    |
| 9d. Leishmaniasis                                      |
| 9e. Lymphatic filariasis                               |
| f. Onchocerciasian                                     |
| 10. Leprosy                                            |
| 11. Dengue                                             |
| 12. Japanese encephalitis                              |
| 13. Trachoma                                           |
| 14. Intestinal nematode infections                     |
| 14a. Ascariasis                                        |
| 14b. Trichuriasis                                      |
| 14c. Ancylostomiasian and necatoriasis                 |
| B. Respiratory infections                              |
| 1. Lower respiratory infections                        |
| 2. Upper respiratory infections                        |
| 3. Otitis media                                        |
| C. Maternal conditions                                 |
| D. Conditions arising during the neonatal period        |
| E. Nutritional deficiencies                            |

Data from the Global Burden of Disease and Risk Factors.

The Global Burden of Infectious Diseases: Main Findings

Mortality from Infectious Disease

Deaths due to infectious diseases for the world and by region, 2001

Worldwide, an estimated 56.2 million people died from all causes in 2001. Almost one third of these deaths (26.1%) were due to infectious causes, and virtually all were in developing regions (14.2 million out of 14.7 million). Mortality from infectious diseases was highest in sub-Saharan Africa, with 6.8 million deaths, and South Asia, with 4.4 million deaths, or 76.4% of all infectious disease deaths (Table 2).
Leading causes of deaths

Five infectious causes ranked among the top ten killers in LMICs: lower respiratory infections (3.4 million deaths), HIV/AIDS (2.6 million deaths), diarrheal diseases (1.8 million deaths), tuberculosis (1.6 million deaths), and malaria (1.1 million deaths) (Table 3). Lower respiratory infections ranked fourth in high-income countries. Lower respiratory infections, diarrheal diseases, and malaria deaths affected predominantly children under 5 years of age: 68.2% of all deaths from these three causes occurred in this age group. HIV/AIDS and tuberculosis affected mostly young adults: 74.4% of all deaths from these two causes occurred between 15 and 59 years of age.

Years of Life Lost to Infectious Causes

In contrast to crude number of deaths, a time-based measure such as YLLs (3,0) takes into account the age at which a death occurs and thus quantifies the loss of life resulting from premature deaths and gives equal weight to deaths occurring at any age. The proportion of all YLLs (3,0) because of premature deaths from lower respiratory infections and diarrheal diseases exceeds the proportion of all YLLs (3,0) because of premature deaths due to ischemic heart disease and cerebrovascular disease, which occur mostly in older age groups.

Disability due to Infectious Causes

Infectious causes did not rank among the 10 leading causes of YLD in low- and middle-income countries or in high-income countries. The first GBD study drew attention on the large burden of nonfatal disabling conditions resulting from a relatively short list of causes In both low- and middle-income regions, neuropsychiatric conditions are the most important cause of disability, accounting for more than 37% of YLDs (3,0) among adults aged 15 and more. Overall, the burden of neuropsychiatric conditions is almost the same for both sexes, but major contributing causes are quite distinct. The burden of depression is 50% higher for females than for males. In contrast, the male burden for alcohol and drug use is nearly 6 times higher than for females and accounts for one-quarter of the male neuropsychiatric burden. Globally, cataract and age-related vision disorders accounted for more than 9% of total YLDs and adult-onset hearing loss for another 5.2%.

Table 2  Regional distribution of deaths due to infectious causes

| Region                      | Infectious and parasitic diseases (IA) | Respiratory infections (IB) | All infectious causes | All causes |
|-----------------------------|----------------------------------------|----------------------------|----------------------|------------|
| East Asia and Pacific       | 1,299                                  | 571                        | 1,870                | 13,070     |
| Europe and Central Asia     | 152                                    | 109                        | 261                  | 5,669      |
| Latin America and the Caribbean | 324                                  | 160                        | 484                  | 3,277      |
| Middle East and North Africa | 216                                    | 110                        | 326                  | 1,914      |
| South Asia                  | 2,987                                  | 1,435                      | 4,422                | 13,557     |
| Sub-Saharan African         | 5,702                                  | 1,094                      | 6,796                | 10,837     |
| World                       | 10,838                                 | 3,830                      | 14,668               | 56,242     |
| Low- and middle-income countries | 10,686                               | 3,481                      | 14,167               | 48,351     |
| High-income countries       | 152                                    | 349                        | 501                  | 7,891      |

Data from the Global Burden of Disease and Risk Factors.

Table 3  The ten leading causes of death, by broad income group, 2001

| High-income countries       | Deaths (in millions) | Low- and middle-income countries | Deaths (in millions) |
|-----------------------------|----------------------|---------------------------------|----------------------|
| All causes                  | 7.89                 | All causes                      | 48.35                |
| 1. Ischemic heart disease   | 1.36                 | 1. Ischemic heart disease       | 5.70                 |
| 2. Cerebrovascular disease  | 0.78                 | 2. Cerebrovascular disease      | 4.61                 |
| 3. Trachea, bronchus, and lung cancer | 0.46               | 3. Lower respiratory infections | 3.41                 |
| 4. Lower respiratory infections | 0.34               | 4. HIV/AIDS                     | 2.55                 |
| 5. Chronic obstructive pulmonary disease | 0.30         | 5. Perinatal conditions         | 2.49                 |
| 6. Colon and rectal cancers | 0.26                 | 6. Chronic obstructive pulmonary disease | 2.38    |
| 7. Alzheimer’s and other dementias | 0.21           | 7. Diarrheal diseases           | 1.78                 |
| 8. Diabetes mellitus        | 0.20                 | 8. Tuberculosis                 | 1.59                 |
| 9. Breast cancer            | 0.16                 | 9. Malaria                      | 1.21                 |
| 10. Stomach cancer          | 0.15                 | 10. Road traffic injuries       | 1.07                 |

Data from the Global Burden of Disease and Risk Factors.
The Global Burden of Infectious Diseases

Distribution of total DALYs

The global burden of disease is expressed as the number of DALYs, which is the sum of YLLs and YLDs for each of the 107 conditions that were included in the GBD classification. Worldwide, a total of 1.5 billion DALYs were lost from all causes as a result of premature death and disability – 90% in LMICs (which comprise 83% of the world’s population). Half of the total burden occurred in sub-Saharan Africa, and one-third in South Asia (Figure 1). Communicable, maternal, perinatal, and nutritional conditions still accounted for 39.8% of total disease burden in LMICs, whereas noncommunicable diseases represented 86.7% of the total burden in high-income countries. Injuries caused 10.9% of total burden (Table 4).

DALYs lost to infectious diseases

In 2001, 413 million DALYs were lost as a consequence of infectious diseases worldwide, or 26.9% of total DALYs (groups IA and IB). The distribution of the burden of infection follows the distribution of group I: Burden of infections mostly affects populations in LMICs, in which 98.6% of the total burden of infections occurred. Patterns of disease burden varied significantly within the low- and middle-income regions. Sub-Saharan Africa and South

Figure 1 The burden of disease by broad cause group, 2001. Data from the Global Burden of Disease and Risk Factors.
Asia, which have the lowest life expectancy, suffered a disproportionate burden due to infectious diseases (Figure 2). HIV/AIDS, malaria, lower respiratory infections, and diarrheal diseases were the four leading causes of DALYs (3.0) in sub-Saharan Africa, and lower respiratory infections and diarrheal diseases ranked among the five leading causes of disease burden in South Asia, the Middle East, and North Africa (Table 5). The number of DALYs for specific infectious diseases worldover, including low-, middle-, and high-income regions, is presented in Tables 6–8.

DALYs lost from infectious diseases that are powerful risk factors for other diseases

Traditional methods of assessing deaths by cause fail to consider the fact that some infectious diseases can be powerful risk factors for other diseases. Several diseases occur from prior or current exposure to an infectious agent. The approach adopted in the global burden of disease study to overcome this limitation and provide a more complete picture of the actual burden related to a small number of infectious diseases was to treat each condition as a risk factor. The study provides estimates of how much of the total burden would be averted in each region if the conditions were eliminated. The largest difference between directly coded and total burden was for hepatitis B and hepatitis C. Infection with hepatitis B virus increases the risk of developing liver cancer and cirrhosis of the liver.

The burden of risk factors for infectious diseases

The GBD assessed the burden of disease associated with the following major risk factors: malnutrition; poor water supply, sanitation, and hygiene; unsafe sex; tobacco use; alcohol use; occupation; hypertension; physical inactivity; illicit drug use; and air pollution. Exposures that underlie the major infectious diseases in young children – malnutrition and poor water supply, sanitation, and hygiene – cause an estimated 20–25% of the total burden of disease. Unsafe sex is a major risk factor for HIV and sexually transmitted diseases, as well as for other maternal conditions (Table 9).

Projecting mortality and morbidity from infectious diseases, 1990–2020

Projections of mortality and disability are essential to guide investments in the health sector worldwide. The first GBD study provided three alternative scenarios of future burden from 1990 to 2020. The projection model used for the study was based on the observed relation between cause-specific mortality and three socioeconomic

| Group/cause                          | High-income countries (%) | Low- and middle-income countries (%) | World (%) |
|--------------------------------------|---------------------------|--------------------------------------|-----------|
| All causes                           | 100.0                     | 100.0                                | 100.0     |
| I. Communicable, maternal, perinatal, and nutritional conditions |                           |                                       |           |
| A. Infectious and parasitic diseases | 2.3                       | 23.1                                 | 21        |
| B. Respiratory infections            | 1.7                       | 6.3                                  | 6         |
| C. Maternal conditions               | 0.3                       | 1.9                                  | 2         |
| D. Conditions arising during the perinatal period | 0.9                       | 6.4                                  | 6         |
| E. Nutritional deficiencies          | 0.6                       | 2.1                                  | 2         |
| II. Noncommunicable diseases         | 86.7                      | 48.9                                 | 53        |
| III. Injuries                        | 7.5                       | 11.2                                 | 10.9      |

Data from the Global Burden of Disease and Risk Factors.
| Rank | South Asia | Sub-Saharan Africa | East Asia and the Pacific | Europe and Central Asia | Middle East and North Africa | Latin America and the Caribbean | High-income countries |
|------|------------|--------------------|--------------------------|------------------------|----------------------------|-------------------------------|---------------------|
|      | (GNI: $450) | (GNI: $460)        | (GNI: $900)              | (GNI: $1,970)          | (GNI: $2,200)              | (GNI: $3,580)                | (GNI: $26,500)       |
|      | LE:63      | LE:46              | LE:69                    | LE:69                  | LE:68                      | LE:71                        | LE:78               |
| 1    | Perinatal conditions¹ | HIV/AIDS | Cerebrovascular diseases | Ischemic heart disease | Ischemic heart disease | Perinatal conditions¹ | Ischemic heart disease |
| 2    | Lower respiratory infections | Malaria | Perinatal conditions¹ | Cerebrovascular diseases | Perinatal conditions¹ | Unipolar depressive disorders | Cerebrovascular diseases |
| 3    | Ischemic heart disease | Lower respiratory infections | Chronic obstructive pulmonary disease | Unipolar depressive disorders | Traffic accidents | Homicide and violence | Unipolar depressive disorders |
| 4    | Diarrheal diseases | Diarrheal diseases | Ischemic heart disease | Self-inflicted injuries | Lower respiratory infections | Ischemic heart disease | Alzheimer’s and other dementias |
| 5    | Unipolar depressive disorders | Perinatal conditions¹ | Unipolar depressive disorders | Chronic obstructive pulmonary disease | Diarrheal diseases | Cerebrovascular diseases | Tracheal and lung cancer |

¹This category includes ‘conditions arising in the perinatal period’ (<28 days) as defined in the International Classification of Diseases, principally low birth weight, prematurity, birth asphyxia, and birth trauma, and does not include all causes of deaths occurring in the perinatal period.

GNI = gross national income per capita (US$); LE = life expectancy at birth (average male and female).

Source: Lopez AD, Mathers CD, Ezzati M, Jamison DT, and Murray CJL (eds.) (2006) Global Burden of Disease and Risk Factors. New York: Oxford University Press.
variables: income per capita, average years of schooling, and tobacco use and time. Three sets of projections of these independent variables formed the basis of the baseline, optimistic, and pessimistic scenarios presented in the GBD.

Dramatic changes in rank order of deaths for the 15 leading causes worldwide are expected to occur between 1990 and 2020. From 1990 to 2020, the baseline projection scenario suggests that ischemic heart disease, unipolar major depression, cerebrovascular disease, chronic obstructive pulmonary disease, HIV, war, violence, suicide, and lung cancer will increase in the relative ranking of causes. The most striking change is projected to occur for deaths due to HIV infection. Although it ranked 28th as a cause of deaths worldwide in 1990, death due to HIV infection is projected to rank 10th in 2020. Major declines in relative rankings are expected for lower respiratory infections, diarrheal diseases, measles, malaria, anemia, and protein-energy malnutrition. Malaria, which ranked 11th as a cause of death worldwide in 1990, will rank 24th in 2020.

Even in the pessimistic scenario, lower respiratory infections and diarrheal diseases would decrease in the relative rankings but would remain larger causes in absolute terms. Lower respiratory infections will remain the leading cause of infectious disease deaths. No change is expected to occur in the ranking for tuberculosis under the baseline scenario (Table 10).

Projections of future health trends were developed using a parsimonious model that included only three variables: (1) income per capita, (2) the average number of years of schooling for adults, and (3) time as a proxy measure for secular improvements in health in this century that resulted in part from accumulating knowledge and technological development. It follows that forecasts in any of the scenarios outlined previously rely on two major implicit assumptions: (1) improvements in hygiene observed during the past decades in developing regions will continue or at least be sustained in the future and (2) no major emerging infection or novel pandemics will occur.

### Table 6 Causes of DALYs (percentage of total) in descending order, 2001 – world top 10 and other infectious diseases

| Rank | Disease or injury | DALYs (millions of years) | % of total DALYs |
|------|------------------|--------------------------|-----------------|
| 1    | All causes       | 1 536.59                 | 5.89            |
| 2    | Perinatal conditions | 90.48                   | 0.58            |
| 3    | Lower respiratory infections | 85.92                 | 5.59            |
| 4    | Ischemic heart disease | 84.27                   | 5.48            |
| 5    | Cerebrovascular disease | 72.02                   | 4.69            |
| 6    | HIV/AIDS         | 71.46                    | 4.65            |
| 7    | Diarrheal diseases | 59.14                    | 3.85            |
| 8    | Unipolar major depression | 51.84                 | 3.37            |
| 9    | Malaria          | 39.97                    | 2.60            |
| 10   | Chronic obstructive pulmonary disease | 38.74 | 2.52 |

Other infectious diseases

| Disease or injury | DALYs (millions of years) | % of total DALYs |
|------------------|--------------------------|-----------------|
| Measles          | 23.11                    | 1.50            |
| Pertussis        | 11.54                    | 0.75            |
| Sexually transmitted diseases excluding HIV/AIDS | 9.48 | 0.62 |
| Tetanus          | 8.34                     | 0.54            |
| Meningitis       | 5.61                     | 0.36            |
| Lymphatic filariasis | 4.67                   | 0.30            |
| Trachoma         | 2.63                     | 0.17            |
| Intestinal nematode infections | 2.35 | 0.15 |
| Hepatitis B      | 2.17                     | 0.14            |
| Leishmaniasis    | 1.76                     | 0.11            |
| Upper respiratory infections | 1.74 | 0.11 |
| Schistosomiasis  | 1.53                     | 0.10            |
| Otitis media     | 1.53                     | 0.10            |
| Trypanosomiasis  | 1.33                     | 0.09            |
| Hepatitis C      | 1.03                     | 0.07            |
| Japanese encephalitis | 0.60                   | 0.04            |
| Chagas’ disease  | 0.59                     | 0.04            |
| Dengue           | 0.53                     | 0.03            |
| Onchocerciasis   | 0.44                     | 0.03            |
| Leprosy          | 0.19                     | 0.01            |
| Diphtheria       | 0.16                     | 0.01            |
| Poliomyelitis    | 0.14                     | 0.01            |

Data from the Global Burden of Disease and Risk Factors.
Policy Implications

The main goal of the GBD was to provide the objective evidence base on the magnitude of the burden of disease due to premature deaths and to nonfatal health outcomes needed to inform international public health policy. As such, the choice of the DALY indicator to quantify the GBD was not a neutral exercise. The vast policy implications of the findings of the study set forth an extensive debate, which challenged the explicit social value choices

Table 7 Causes of DALYs (percentage of total) in descending order, 2001 – low- and middle-income regions top 10 and other infectious diseases

| Rank | Disease or injury | DALY’s (millions of years) | % of total DALYs |
|------|------------------|----------------------------|-----------------|
| All causes | 1386.71 | 6.42 |
| 1 | Perinatal conditions | 89.07 | 6.03 |
| 2 | Lower respiratory infections | 83.61 | 5.18 |
| 3 | Ischemic heart disease | 71.88 | 5.12 |
| 4 | HIV/AIDS | 70.8 | 4.52 |
| 5 | Cerebrovascular disease | 43.43 | 2.88 |
| 6 | Diarrheal diseases | 39.96 | 2.59 |
| 7 | Unipolar major depression | 38.7 | 2.41 |
| 8 | Malaria | 35.87 | 2.41 |
| 9 | Tuberculosis | 33.45 | 2.41 |
| 10 | Chronic obstructive pulmonary disease | 23.09 | 1.67 |
| Other infectious diseases | | |
| Measles | 9.34 | 0.67 |
| Sexually transmitted diseases excluding HIV/AIDS | | |
| Tetanus | 8.34 | 0.60 |
| Pertussis | 8.34 | 0.60 |
| Meningitis | 5.48 | 0.39 |
| Lymphatic filariasis | 4.68 | 0.32 |
| Trachoma | 2.62 | 0.19 |
| Intestinal nematode infections | 2.34 | 0.17 |
| Hepatitis B | 2.08 | 0.15 |
| Leishmaniasis | 1.76 | 0.13 |
| Upper respiratory infections | 1.68 | 0.12 |
| Schistosomiasis | 1.53 | 0.11 |
| Otitis media | 1.42 | 0.10 |
| Trypanosomiasis | 1.33 | 0.10 |
| Hepatitis C | 0.84 | 0.06 |
| Japanese encephalitis | 0.60 | 0.04 |
| Chagas’ disease | 0.58 | 0.04 |
| Dengue | 0.53 | 0.04 |
| Onchocerciasis | 0.44 | 0.03 |
| Leprosy | 0.19 | 0.01 |
| Diphtheria | 0.16 | 0.01 |
| Polymyelitis | 0.14 | 0.01 |

Table 8 Causes of DALYs (percentage of total) in descending order, 2001 – high-income regions, top ten and other infectious diseases

| Disease or injury | DALY’s (millions of years) | % of total DALYs |
|------------------|-----------------------------|-----------------|
| All causes | 149.16 | 8.31 |
| 1 | Ischemic heart disease | 12.39 | 8.31 |
| 2 | Cerebrovascular disease | 9.35 | 6.27 |
| 3 | Unipolar major depression | 8.41 | 5.64 |
| 4 | Alzheimer’s and other dementias | 7.47 | 5.01 |
| 5 | Trachea, bronchus, and lung cancer | 5.4 | 3.62 |
| 6 | Hearing loss, adult onset | 5.39 | 3.61 |
| 7 | Chronic obstructive pulmonary disease | 5.28 | 3.54 |
| 8 | Diabetes mellitus | 4.19 | 2.81 |
| 9 | Alcohol use disorders | 4.17 | 2.80 |
| 10 | Osteoarthritis | 3.79 | 2.54 |

Other infectious diseases

| Disease or injury | DALY’s (millions of years) | % of total DALYs |
|------------------|-----------------------------|-----------------|
| Lymphatic filariasis | 0.21 | 0.14 |
| Hepatitis C | 0.19 | 0.12 |
| Sexually transmitted diseases excluding HIV/AIDS | 0.15 | 0.10 |

Data from the Global Burden of Disease and Risk Factors.

embedded in the DALY: the sex difference in the standard length of life, the choice of severity weights for different disabilities, the introduction of age weights, and the discounting of future health outcomes. The following major recommendations for public health policy were derived from the GBD:

1. The magnitude of the remaining burden due to infectious diseases in developing countries, despite the sustained efforts to reduce child mortality during the past few decades, underscore the need for lower respiratory infections, diarrheal diseases, tuberculosis, malaria, and hepatitis B and C to remain a key priority for global public health action.
2. Although the high mortality due to infectious diseases in developing countries was already well known, the finding that deaths from two major cardiovascular
**Table 9** Individual and joint contributions of risk factors to leading causes of infectious diseases, 2001

| Disease                        | Proportion of total disease burden (%) | Proportion of global mortality (%) | PAFs for individual risk factors (for disease burden)                                                                 | Joint PAF\(^a\) - disease burden (%) | Joint PAF\(^a\) - mortality (%) |
|-------------------------------|----------------------------------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------|---------------------------------------|----------------------------------|
| **World**                     | Total: 1.54 billion DALYs               | Total: 56.2 million deaths        |                                                                                                                     |                                       |                                  |
| Lower respiratory infections  | 5.6                                    | 6.7                               | Childhood underweight (37%); zinc deficiency (15%); indoor smoke from solid fuels (35%); smoking (4%); urban air pollution (1%) | 53                                    | 42                               |
| HIV/AIDS                      | 4.7                                    | 4.6                               | Unsafe sex (95%); contaminated injections in health care settings (5%); illicit drug use (3%)                         | 96                                    | 96                               |
| Diarrheal diseases            | 3.9                                    | 3.2                               | Childhood underweight (37%); vitamin A deficiency (22%); zinc deficiency (12%); unsafe water, sanitation, and hygiene (88%) | 92                                    | 93                               |
| Malaria                       | 2.6                                    | 2.1                               | Childhood underweight (51%); vitamin A deficiency (19%); zinc deficiency (22%)                                     | 59                                    | 61                               |
| Tuberculosis                  | 2.4                                    | 2.9                               | Smoking (4%)                                                                                                       |                                       |                                  |
| **Low- and middle-income countries** | Total: 1.39 billion DALYs               | Total: 48.3 million deaths        |                                                                                                                     |                                       |                                  |
| Lower respiratory infections  | 6.0                                    | 7.0                               | Childhood underweight (38%); zinc deficiency (16%); indoor smoke from solid fuels (36%); smoking (4%); urban air pollution (4%) | 54                                    | 44                               |
| HIV/AIDS                      | 5.1                                    | 5.3                               | Unsafe sex (95%); contaminated injections in health care settings (5%); illicit drug use (3%)                         | 97                                    | 97                               |
| Diarrheal diseases            | 4.2                                    | 3.7                               | Childhood underweight (56%); vitamin A deficiency (22%); zinc deficiency (12%); unsafe water, sanitation, and hygiene (88%) | 93                                    | 94                               |
| Malaria                       | 2.9                                    | 2.5                               | Childhood underweight (51%); vitamin A deficiency (19%); zinc deficiency (22%)                                     | 59                                    | 61                               |
| Tuberculosis                  | 2.6                                    | 3.3                               | Smoking (4%)                                                                                                       | 9                                     | 10                               |

\(^a\)PAF: population attributable fraction.
Data from the Global Burden of Disease and Risk Factors.
causes (ischemic heart disease and cerebrovascular disease) were the second and third leading cause of death in LMICs was a significant surprise. Also noteworthy was the finding that deaths from road traffic accidents were among the top ten causes in all regions. The major implication of these findings is that they need to be included in the international public health policy debate.

3. It is essential to include the burden of nonfatal health outcomes in the global assessment of health problems because it notoriously shifts the ranking of priorities. The burden of neuropsychiatric conditions and sexually transmitted diseases had been greatly underestimated.

4. Although some diseases and injuries occur without prior exposure to health hazards, review of the contribution of one or more major risk factor for respiratory infections and diarrheal diseases illustrates the importance of exposures that underlie major infectious diseases mostly in developing countries. Their control must remain a priority. In the absence of sustained efforts to improve hygiene and sustained vigilance about emerging infections and novel pandemics, forecasts about the pace of the epidemiological transition from a predominance of infectious diseases to a predominance of chronic conditions may well be self-negated. It has been well documented that average improvement in GNP per capita does not always translate into good health for all.

5. Evidence-based health policy formulation will require regular updates of global and regional information to better monitor trends for planning purposes.

See also: HIV/AIDS; Vaccine Development: The Development of Avian Influenza Vaccines for Human Use; Surveillance of Infectious Diseases

Further Reading
Anand S and Hanson K (1997) Disability-adjusted life years: A critical review. Journal of Health Economics 16(6): 685–702.
Baker C and Green A (1996) Opening the debate on DALYs. Health Policy and Planning 11(2): 179–183.
Lopez AD, Mathers CD, Ezzati M, Jamison DT, and Murray CJL (eds.) (2006) Global Burden of Disease and Risk Factors. New York: Oxford University Press.
Murray CJL and Acharya AK (1997) Understanding DALYs. Journal of Health Economics 16: 703–730.
Murray CJL and Lopez AD (1996a) The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability from Diseases, Injuries and Risk Factors in 1990 and Projected to 2020. Cambridge, MA: Harvard University Press.
Murray CJL and Lopez AD (1996b) Global Health Statistics. A Compendium of Incidence and Prevalence Estimates for over 200 Conditions. Cambridge, MA: Harvard University Press.
Murray CJL and Lopez AD (1996c) Evidence-based health policy – Lessons from the global burden of disease study. Science 274: 740–743.