REVIEW ARTICLE

GLOBAL HEALTH

Measuring the Global Burden of Disease

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It is difficult to deliver effective and high-quality care to patients without knowing their diagnoses; likewise, for health systems to be effective, it is necessary to understand the key challenges in efforts to improve population health and how these challenges are changing. Before the early 1990s, there was no comprehensive and internally consistent source of information on the global burden of diseases, injuries, and risk factors. To close this gap, the World Bank and the World Health Organization launched the Global Burden of Disease (GBD) Study in 1991.[1] Although assessments of selected diseases, injuries, and risk factors in selected populations are published each year (e.g., the annual assessments of the human immunodeficiency virus [HIV] epidemic[2]), the only comprehensive assessments of the state of health in the world have been the various revisions of the GBD Study for 1990, 1999–2002, and 2004.[1,3-10] The advantage of the GBD approach is that consistent methods are applied to critically appraise available information on each condition, make this information comparable and systematic, estimate results from countries with incomplete data, and report on the burden of disease with the use of standardized metrics.

The most recent assessment of the global burden of disease is the 2010 study (GBD 2010), which provides results for 1990, 2005, and 2010. Several hundred investigators collaborated to report summary results for the world and 21 epidemiologic regions in December 2012.[11-18] Regions based on levels of adult mortality, child mortality, and geographic contiguity were defined. GBD 2010 addressed a number of major limitations of previous analyses, including the need to strengthen the statistical methods used for estimation.[11] The list of causes of the disease burden was broadened to cover 291 diseases and injuries. Data on 1160 sequelae of these causes (e.g., diabetic retinopathy, diabetic neuropathy, amputations due to diabetes, and chronic kidney disease due to diabetes) have been evaluated separately. The mortality and burden attributable to 67 risk factors or clusters of risk factors were also assessed.

GBD 2010, which provides critical information for guiding prevention efforts, was based on data from 187 countries for the period from 1990 through 2010. It includes a complete reassessment of the burden of disease for 1990 as well as an estimation for 2005 and 2010 based on the same definitions and methods; this facilitated meaningful comparisons of trends. The prevalence of coexisting conditions was also estimated according to the year, age, sex, and country. Detailed results from global and regional data have been published previously.[11-18]

The internal validity of the results is an important aspect of the GBD approach. For example, demographic data on all-cause mortality according to the year, country, age, and sex were combined with data on cause-specific mortality to ensure that the sum of the number of deaths due to each disease and injury equaled the number of deaths from all causes. Similar internal-validity checks were used for

cause-specific estimates related to impairments such as hearing loss and vision loss, anemia, heart failure, intellectual disability, infertility, and epilepsy when there were substantial data on the overall levels of the impairment.

Although GBD 2010 provides the most comprehensive and consistent assessment of global data on descriptive epidemiology, there remain many limitations. There were insufficient data on many diseases, injuries, and risk factors from many countries. Estimates depended on sophisticated statistical modeling to address sparse and often inconsistent data.[13,16,19,20] All outcomes were measured with 95% uncertainty intervals, which captured uncertainty from sampling, nonsampling error from the study designs or diagnostic methods, model parameter uncertainty, and uncertainty regarding model specification. This combined assessment of uncertainty was meant to communicate the strength of the evidence available for a particular condition in a particular place.

To compare the burden of one disease with that of another, it is necessary to consider the age at death and life expectancy of persons affected by each disease and to take account of the degree of disability (e.g., discomfort, pain, or functional limitations) imposed by each condition on those who live with the disease. In GBD 2010, years of life lost due to premature death were computed by multiplying the numbers of deaths by the life expectancy at the time of death in a reference population; this reference population was chosen as a population with a life expectancy at birth of 86.0 years, according to the lowest observed mortality in age groups for each sex.[11] A death at 1 year of age represents 85.2 years of life lost, and a death at 25 years of age represents 61.4 years of life lost. The same reference life expectancy at birth is used for males and females.[11] Because of a huge variation in severity, it is not very meaningful to compare the number of persons in the world with disorders as different as eczema, dental caries, scabies, major depression, multiple sclerosis, and tuberculosis. In GBD 2010, various sequelae were compared with the use of disability weights that were derived from surveys of the general population in five countries and an open Internet survey.[14] These surveys used pairwise comparisons and questions on population health equivalence, which ask respondents to assess improvements in health produced by various interventions that change disability or prevent premature death, to generate disability weights on a scale from 0.0 to 1.0, with 0.0 indicating ideal health and 1.0 indicating a state of health equivalent to death.[14] Years lived with disability were computed as the prevalence of a sequela multiplied by the disability weight for that sequela. Because years of life lost and years lived with disability were measured in units of healthy life lost, they were reported with the use of a comprehensive summary metric — disability-adjusted life-years (DALYs). In the lexicon of GBD 2010, disability is synonymous with any short-term or long-term health loss. In response to the recommendations of a panel of philosophers and ethicists, DALYs in GBD 2010 were not discounted or weighted according to age.[11]

Different metrics highlight different aspects of the health status of a population. Table 1 shows metrics for the United States, including the set of specific conditions that account for the 10 leading causes of death, years of life lost, years lived with disability, and DALYs. The numerical value for each metric and the rank for that cause across all causes listed in GBD 2010 are shown. These data provide various perspectives on the leading health problems in the United States. Large numbers of DALYs due to low back pain, other musculoskeletal disorders, neck pain, and osteoarthritis, along with DALYs due to vision loss, hearing loss, and anemias, highlight how metrics that capture all short-term or long-term decreases in health functioning yield a distinctive perspective. In the United States, the top 10 causes of the burden of disease as assessed with the use of DALYs include cardiovascular diseases (ischemic heart disease and stroke), chronic obstructive pulmonary disease (COPD), one type of cancer (of the trachea, bronchus, or lung), three musculoskeletal disorders (low back pain, other musculoskeletal disorders, and neck pain), major depressive disorder, diabetes, and road-traffic injury.

SOME KEY FINDINGS FROM GBD 2010

Many findings in this study of 291 types of diseases and injuries and 67 risk factors in 187 countries over time have policy implications. In 1990, there were 2497 million global DALYs; this num-

Table 1. Top 10 Causes of Death, Years of Life Lost from Premature Death, Years Lived with Disability, and Disability-Adjusted Life-Years (DALYs) in the United States, 2010.

Cause of Death	Deaths (N=2664)		Years of Life Lost (N=45,145)		Years Lived with Disability (N=36,689)		DALYs (N=81,835)	
	Rank	No. (%) *in thousands*	Rank	No. (%) *in thousands*	Rank	No. (%) *in thousands*	Rank	No. (%) *in thousands*
Ischemic heart disease	1	563 (21.1)	1	7165 (15.9)	16	685 (1.9)	1	7850 (9.6)
Chronic obstructive pulmonary disease	5	154 (5.8)	4	1913 (4.2)	6	1745 (4.8)	2	3659 (4.5)
Low back pain	—	—	—	—	1	3181 (8.7)	3	3181 (3.9)
Cancer of the trachea, bronchus, or lung	3	163 (6.1)	2	2988 (6.6)	73	45 (0.1)	4	3033 (3.7)
Major depressive disorder	—	—	—	—	2	3049 (8.3)	5	3049 (3.7)
Other musculoskeletal disorders	36	14 (0.5)	37	254 (0.6)	3	2603 (7.1)	6	2857 (3.5)
Stroke	2	172 (6.5)	3	1945 (4.3)	17	629 (1.7)	7	2574 (3.1)
Diabetes mellitus	6	86 (3.2)	7	1392 (3.1)	8	1165 (3.2)	8	2557 (3.1)
Road-traffic injury	12	44 (1.7)	5	1873 (4.1)	26	373 (1.0)	9	2246 (2.7)
Drug-use disorders	27	19 (0.7)	15	841 (1.9)	7	1295 (3.5)	10	2136 (2.6)
Neck pain	—	—	—	—	4	2134 (5.8)	11	2134 (2.6)
Alzheimer's disease and other dementias	4	158 (5.9)	9	1192 (2.6)	12	830 (2.3)	12	2022 (2.5)
Anxiety disorders	—	—	—	—	5	1866 (5.1)	13	1866 (2.3)
Self-harm	16	37 (1.4)	6	1457 (3.2)	121	6 (<0.05)	14	1463 (1.8)
Cirrhosis of the liver	11	50 (1.9)	8	1233 (2.7)	98	16 (<0.05)	16	1249 (1.5)
Chronic kidney disease	9	60 (2.3)	16	780 (1.7)	22	410 (1.1)	17	1191 (1.5)
Colorectal cancers	8	64 (2.4)	10	1074 (2.4)	56	73 (0.2)	18	1147 (1.4)
Lower respiratory tract infections	7	85 (3.2)	11	1032 (2.3)	62	61 (0.2)	20	1093 (1.3)
Asthma	61	4 (0.2)	57	100 (0.2)	10	932 (2.5)	24	1032 (1.3)
Osteoarthritis	—	—	—	—	9	994 (2.7)	25	994 (1.2)
Other cardiovascular and circulatory diseases	10	57 (2.1)	17	765 (1.7)	34	213 (0.6)	26	979 (1.2)

ber decreased slightly, to 2482 million DALYs, in 2010. The steady volume of DALYs masks major changes in the distribution of the burden according to age, sex, country, and cause. On the basis of population growth alone, we would have expected the number of DALYs to increase by 37.9%; the small overall decrease of 0.6% was largely due to progress in reducing DALY rates according to age and sex.

Table 2 shows the 25 leading causes of DALYs in the world in 2010 in order, as well as the rank and number of DALYs in 1990. The leading causes included communicable diseases, noncommunicable diseases, and some injuries. The major causes of death in children in low-income countries in 1990, including lower respiratory tract infections, diarrhea, malaria, complications of preterm birth, and neonatal encephalopathy, were among the top 15 DALYs in 2010. In addition, HIV infection and the acquired immune deficiency syndrome (HIV–AIDS) and tuberculosis remained in the top 15 causes of DALYs. Noncommunicable diseases such as ischemic heart disease, stroke, COPD, and diabetes — which primarily cause premature death — were among the top 15 causes of

Table 2. Global DALYs Caused by the 25 Leading Diseases and Injuries in 1990 and 2010.

Cause	2010		1990	
	Rank	DALYs (95% UI) *in thousands*	Rank	DALYs (95% UI) *in thousands*
Ischemic heart disease	1	129,795 (119,218–137,398)	4	100,455 (96,669–108,702)
Lower respiratory tract infections	2	115,227 (102,255–126,972)	1	206,461 (183,354–222,979)
Stroke	3	102,239 (90,472–108,003)	5	86,012 (81,033–94,802)
Diarrhea	4	89,524 (77,595–99,193)	2	183,543 (168,791–197,655)
HIV–AIDS	5	81,549 (74,698–88,371)	33	18,118 (14,996–22,269)
Malaria	6	82,689 (63,465–109,846)	7	69,141 (54,547–85,589)
Low back pain	7	80,667 (56,066–108,723)	12	56,384 (38,773–76,233)
Preterm birth complications	8	76,980 (66,210–88,132)	3	105,965 (88,144–120,894)
Chronic obstructive pulmonary disease	9	76,779 (66,000–89,147)	6	78,298 (70,407–86,849)
Road-traffic injury	10	75,487 (61,555–94,777)	11	56,651 (49,633–68,046)
Major depressive disorder	11	63,239 (47,894–80,784)	15	46,177 (34,524–58,436)
Neonatal encephalopathy*	12	50,163 (40,351–59,810)	10	60,604 (50,209–74,826)
Tuberculosis	13	49,399 (40,027–56,009)	8	61,256 (55,465–71,083)
Diabetes mellitus	14	46,857 (40,212–55,252)	21	27,719 (23,668–32,925)
Iron-deficiency anemia	15	45,350 (31,046–64,616)	14	46,803 (32,604–66,097)
Sepsis and other infectious disorders in newborns	16	44,236 (27,349–72,418)	17	46,029 (25,147–70,357)
Congenital anomalies	17	38,890 (31,891–45,739)	13	54,245 (45,491–69,057)
Self-harm	18	36,655 (26,894–44,652)	19	29,605 (23,039–37,333)
Falls	19	35,406 (28,583–44,052)	22	25,900 (21,252–31,656)
Protein-energy malnutrition	20	34,874 (27,957–41,662)	9	60,542 (50,378–71,639)
Neck pain	21	32,651 (22,783–44,857)	25	23,107 (16,031–31,890)
Cancer of the trachea, bronchus, or lung	22	32,405 (24,401–38,327)	24	23,850 (18,839–29,837)
Other musculoskeletal disorders	23	30,877 (25,858–34,650)	29	20,596 (17,025–23,262)
Cirrhosis of the liver	24	31,026 (25,951–34,629)	23	24,325 (20,653–27,184)
Meningitis	25	29,407 (25,578–33,442)	18	37,822 (33,817–44,962)

* The category of neonatal encephalopathy includes birth asphyxia and birth trauma.

DALYs; disabling conditions such as low back pain and major depressive disorder were also leading causes. Low back pain, for example, affects 10% of the world population and ranges from mild to quite severe. Three types of injuries were among the top 25 causes of DALYs; road-traffic injuries, which caused the most DALYs, increased by 33% between 1990 and 2010. A comparison of data from 1990 with data from 2010 shows some profound shifts. In general, communicable, maternal, neonatal, and nutritional conditions decreased in absolute terms (both in numbers of DALYs and rates) and relative to noncommunicable diseases; the notable exceptions were malaria and HIV–AIDS. The burden of noncommunicable diseases, both from the causes of years of life lost and the causes of years lived with disability, has been increasing in terms of the absolute number of years of life lost and years lived with disability and in terms of the share of the total burden over the two decades, with the largest increases associated with diabetes.

The burden of disease attributable to risk factors is shown in Table 3. The leading risk factors changed substantially, and there were major

Table 3. Global DALYs Attributable to the 25 Leading Risk Factors in 1990 and 2010.

Risk Factor	2010		1990	
	Rank	DALYs (95% UI) *in thousands*	Rank	DALYs (95% UI) *in thousands*
High blood pressure	1	173,556 (155,939–189,025)	4	137,017 (124,360–149,366)
Tobacco smoking, including exposure to secondhand smoke	2	156,838 (136,543–173,057)	3	151,766 (136,367–169,522)
Household air pollution from solid fuels	3	108,084 (84,891–132,983)	2	170,693 (139,087–199,504)
Diet low in fruit	4	104,095 (81,833–124,169)	7	80,453 (63,298–95,763)
Alcohol use	5	97,237 (87,087–107,658)	8	73,715 (66,090–82,089)
High body-mass index	6	93,609 (77,107–110,600)	10	51,565 (40,786–62,557)
High fasting plasma glucose level	7	89,012 (77,743–101,390)	9	56,358 (48,720–65,030)
Childhood underweight	8	77,316 (64,497–91,943)	1	197,741 (169,224–238,276)
Exposure to ambient particulate-matter pollution	9	76,163 (68,086–85,171)	6	81,699 (71,012–92,859)
Physical inactivity or low level of activity	10	69,318 (58,646–80,182)	—	—
Diet high in sodium	11	61,231 (40,124–80,342)	12	46,183 (30,363–60,604)
Diet low in nuts and seeds	12	51,289 (33,482–65,959)	13	40,525 (26,308–51,741)
Iron deficiency	13	48,225 (33,769–67,592)	11	51,841 (37,477–71,202)
Suboptimal breast-feeding	14	47,537 (29,868–67,518)	5	110,261 (69,615–153,539)
High total cholesterol level	15	40,900 (31,662–50,484)	14	39,526 (32,704–47,202)
Diet low in whole grains	16	40,762 (32,112–48,486)	18	29,404 (23,097–35,134)
Diet low in vegetables	17	38,559 (26,006–51,658)	16	31,558 (21,349–41,921)
Diet low in seafood n–3 fatty acids	18	28,199 (20,624–35,974)	20	21,740 (15,869–27,537)
Drug use	19	23,810 (18,780–29,246)	25	15,171 (11,714–19,369)
Occupational risk factors for injuries	20	23,444 (17,736–30,904)	21	21,265 (16,644–26,702)
Occupation-related low back pain	21	21,750 (14,492–30,533)	23	17,841 (11,846–24,945)
Diet high in processed meat	22	20,939 (6982–33,468)	24	17,359 (5137–27,949)
Intimate-partner violence	23	16,794 (11,373–23,087)	—	—
Diet low in fiber	24	16,452 (7401–25,783)	26	13,347 (5970–20,751)
Lead exposure	25	13,936 (11,750–16,327)	31	5,365 (4534–6279)

shifts in the burden of disease between 1990 and 2010. In 1990, the leading risk factor was childhood underweight, which was ranked 8th among the risk factors evaluated in 2010, representing an absolute decrease in DALYs of 61%. Other major decreases were observed in the burden attributable to household air pollution (from 2nd to 3rd rank), suboptimal breast-feeding (defined as nonexclusive breast-feeding for up to 6 months of life and discontinued breast-feeding between 6 and 23 months of life) (5th to 14th rank), unimproved sanitation (15th to 26th rank), vitamin A deficiency (17th to 29th rank), zinc deficiency (19th to 31st rank), and unimproved water sources (22nd to 34th rank). Conversely, increases in attributable DALYs of more than 30% occurred for the following risk factors: obesity (high body-mass index), a high fasting plasma glucose level, a high-sodium diet, a diet low in whole grains, drug-use disorders, and lead exposure. The list of leading risk factors includes multiple components of diet, each of which were evaluated in isolation; taken together, all components of diet and physical inactivity accounted for 10.2% of global DALYs in 2010. The burden attributable to tobacco smoking (including exposure to secondhand smoke) remained roughly constant (6.3% of DALYs in 2010) from 1990 to 2010 because of decreased smoking in high-income countries and increased

smoking in developing regions, most notably in East Asia.

THREE GLOBAL DRIVERS OF RAPID TRANSITIONS IN GLOBAL HEALTH

Three broad transitions explain much of the changing pattern in global health: demographic changes, changes in causes of death, and changes in causes of disability. Demographic effects on the burden of disease include both the increase in the numbers of people and the effect of an increasing average age of the population. As part of GBD 2010, investigators measured the change from 1990 to 2010 in the burden of disease expected on the basis of increases in population size and the aging of the world population. The effects of population growth alone would increase the number of DALYs from all causes, but because population growth was largest in sub-Saharan Africa, it would differentially increase DALYs caused by communicable, maternal, neonatal, and nutritional diseases by 47.6%, those caused by noncommunicable diseases by 27.8%, and those caused by injuries by 32.6%. The increasing mean age of the population, however, decreased the number of DALYs from communicable, maternal, neonatal, and nutritional diseases by 22.2% but increased DALYs associated with noncommunicable diseases by 19.1%. Demographic change (population growth and aging) is the key driver of increases in the burden of noncommunicable diseases; at the global level, age-specific rates of nearly all conditions are actually decreasing.

The second major transition is the change in age-specific and sex-specific rates of death associated with diseases and injuries. From 1990 to 2010, in the aggregate category of communicable, maternal, neonatal, and nutritional diseases, DALYs decreased by 52.1% because of decreases in age-specific and sex-specific rates of death — notably, this overall decrease occurred despite the increases in DALYs due to HIV–AIDS and smaller increases in DALYs due to malaria over this period. This decrease may be related to a combination of increasing levels of maternal education, improved delivery of preventive and medical care with key forms of technology, increasing income per capita, and increasing health expenditures, including development assistance for public health and medical care.[21-24] Decreases in global DALYs due to noncommunicable diseases were more modest, at 22.4%, because of lower age-specific and sex-specific rates of noncommunicable diseases and were even more modest for injuries (20.2%). At a slightly more detailed level, changes in age-specific and sex-specific rates of DALYs led to a 33.6% decrease in global DALYs due to cardiovascular causes and a 24.0% decrease in age-specific and sex-specific global cancer rates. These decreases in the face of the increasing prevalence of some risk factors such as obesity and tobacco use suggest the important role of other factors, including better prenatal care and early-childhood interventions, prevention and treatment provided by health systems, and improvements in socioeconomic status. Although the decreases in rates of noncommunicable diseases and injuries are small, the decreases indicate that the relative importance of noncommunicable diseases and injuries as a share of causes of death will increase. Progress in reducing global age-specific and sex-specific rates of death associated with all three major groups of causes (communicable diseases, noncommunicable diseases, and injuries) is reflected in the increase from 1990 to 2010 in the global life expectancy at birth from 62.8 years to 67.5 years for men and from 68.1 years to 73.3 years for women. Both demographic change and change in age-specific and sex-specific mortality drive the shift toward a larger fraction of the burden due to noncommunicable diseases. Figure 1A shows the fraction of the total burden from noncommunicable diseases according to country in 2010. In most of Latin America, North Africa, the Middle East, Southeast Asia, and East Asia, the substantial majority of the burden was from noncommunicable diseases. Even in South Asia, the fraction due to noncommunicable diseases was more than 40%.

The third transition is a profound shift toward a greater fraction of the burden of disease from disability than from premature death. Of the top 25 causes of years lived with disability, only COPD, diabetes, road-traffic injury, ischemic heart disease, tuberculosis, and diarrhea are also among the top 25 causes of years of life lost. Simply put, what ails most persons is not necessarily what kills them. Major groups of disorders that cause disability include musculoskeletal disorders, mental disorders and substance

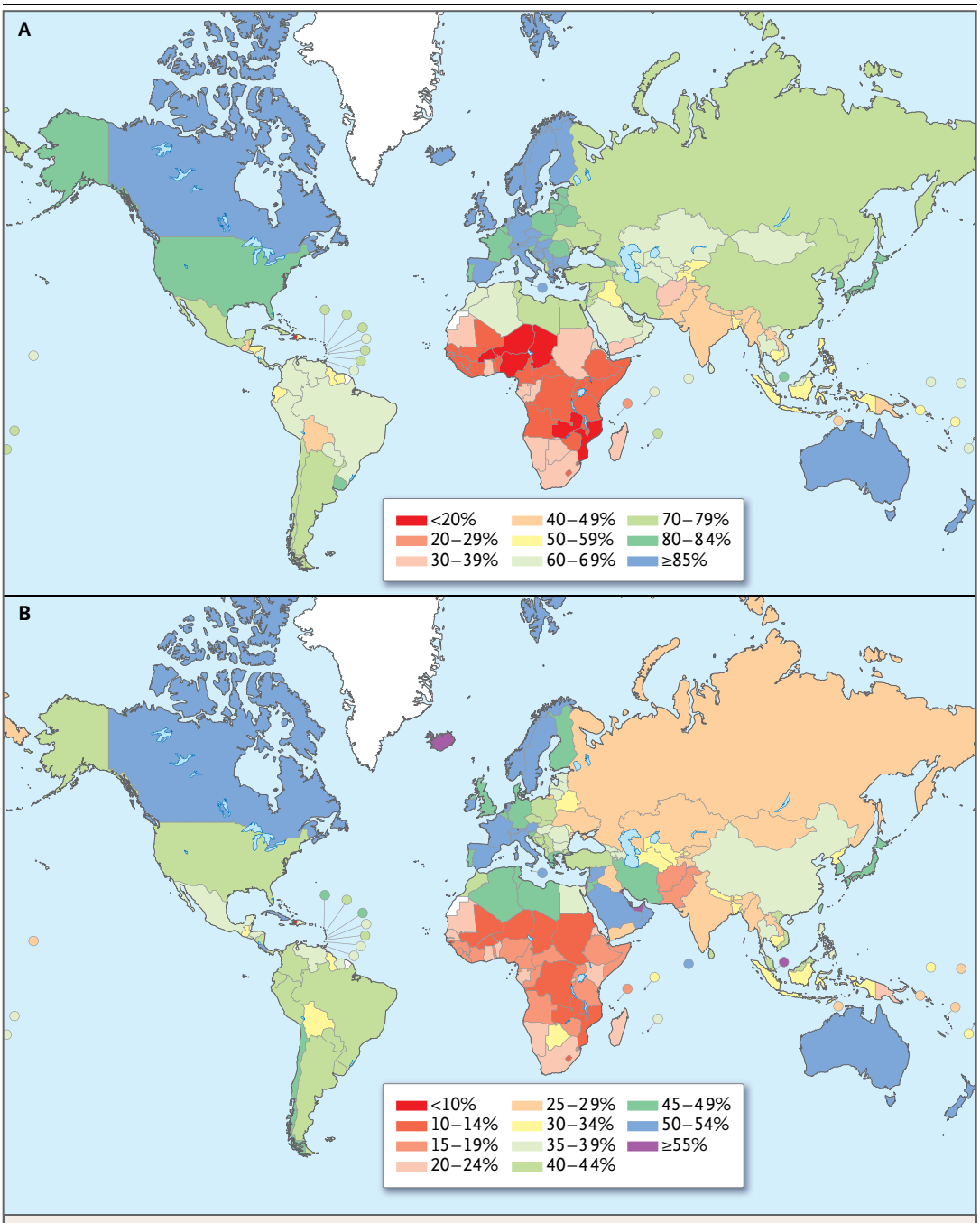

Figure 1. Percentage of Total Disability-Adjusted Life-Years (DALYs) in 2010 According to Country.

Panel A shows the percentage of total DALYs due to noncommunicable diseases in each country. Noncommunicable diseases are defined in the hierarchical list of causes[11] in the Global Burden of Disease 2010 study and include the following major cause groups: cancers; cardiovascular and circulatory diseases; chronic respiratory diseases; cirrhosis; digestive diseases; neurologic conditions; mental and behavioral disorders; diabetes; urogenital, blood, and endocrine diseases; musculoskeletal diseases; and other noncommunicable diseases such as congenital anomalies and skin diseases. Panel B shows the percentage of total DALYs due to years lived with disability per country.

abuse, neurologic conditions, anemias, vision loss, hearing loss, diabetes, and skin diseases. Age-specific and sex-specific prevalence rates of nearly all these conditions are stable or decreasing only slightly, and the rates of some conditions, such as diabetes, are increasing. Stable or increasing rates combined with population growth and aging lead to substantial increases in the number of years lived with these disabling conditions. Overall, there is a progressive shift toward a larger share of the burden of disease from disability. Figure 1B shows the fraction of the burden attributable to disability in 2010 according to country; more than 40% of the disease burden in many developed countries, much of Latin America, North Africa, the Middle East, and parts of Southeast Asia was from disability. The fraction of the burden from years lived with disability increased from 1990 to 2010 in nearly all countries. Disabling conditions cause a substantial loss of healthy life and are costly for health systems to manage.[25,26]

The three major transitions account at a broad level for much of the change in global health, but they do not explain the entire story. There are marked regional and national divergences from this general pattern. The development of large HIV epidemics in eastern sub-Saharan Africa and southern sub-Saharan Africa has had an enormous effect on the burden of disease in those regions. Interpersonal violence is among the top 5 causes of the disease burden in Guatemala, Honduras, El Salvador, Colombia, Venezuela, Ecuador, Bahamas, Mexico, Jamaica, and Brazil. It is also among the top 5 causes of the burden in South Africa, Lesotho, Namibia, Botswana, and Swaziland. Malaria is a leading cause of the disease burden in areas from West Africa to Madagascar where malaria is hyperendemic (defined as parasitemia in >50% of the population) or mesoendemic (defined as parasitemia in 10 to 50% of the population). There is a particularly large burden of diabetes in Central America, the Caribbean, North Africa, the Middle East, and Oceania. The demographic changes, changes in mortality associated with disease and injuries, and changes in causes of disability, combined with local variations in the disease burden, have led to important differences among countries. Thirteen different causes (HIV–AIDS, diarrhea, lower respiratory tract infections, malaria, preterm birth conditions, ischemic heart disease, stroke, major depressive disorder, diabetes, low back pain, road-traffic injury, violence, and natural disasters) account for the leading causes of disease and injury burden in at least 1 country. A similar assessment of the leading risk factor according to country shows that eight different risk factors account for the leading cause of attributable DALYs across countries. These risk factors are alcohol use (in 22 countries), high body-mass index (in 32 countries), suboptimal breast-feeding (in 2 countries), a high fasting plasma glucose level (in 3 countries), household air pollution (in 14 countries), high systolic blood pressure (in 59 countries), smoking (in 24 countries), and childhood underweight (in 31 countries).

GBD 2010 RESULTS FOR BENCHMARKING

An important dimension of GBD 2010 is the capacity to use consistent data and metrics to compare the health outcomes of one nation with those of other countries. Comparisons over time and across nations help to place local performance in health improvement in context; this analysis has already been published in the United Kingdom.[27] For example, the age-standardized mortality or DALY rates in each country can be computed and then ranked across the 187 countries. These rankings provide information on how a country is doing relative to other countries. Changes in these ranks provide insights into relative performance. Figure 2 shows the leading causes of death in the United States and the associated rank of the age-standardized mortality in 1990 and 2010, with 95% uncertainty intervals. Ranks are a relative measure; a higher (worse) rank may be due to increasing age-standardized rates or to decreases that are smaller than those in other nations. This figure shows that for the leading causes of death, the United States has the best global performance with respect to stroke and the worst relative performance with respect to lung cancer and Alzheimer's disease. Significant improvements in relative rank are shown for ischemic heart disease and breast cancer. Significant decreases in relative performance are shown for COPD and diabetes. Data

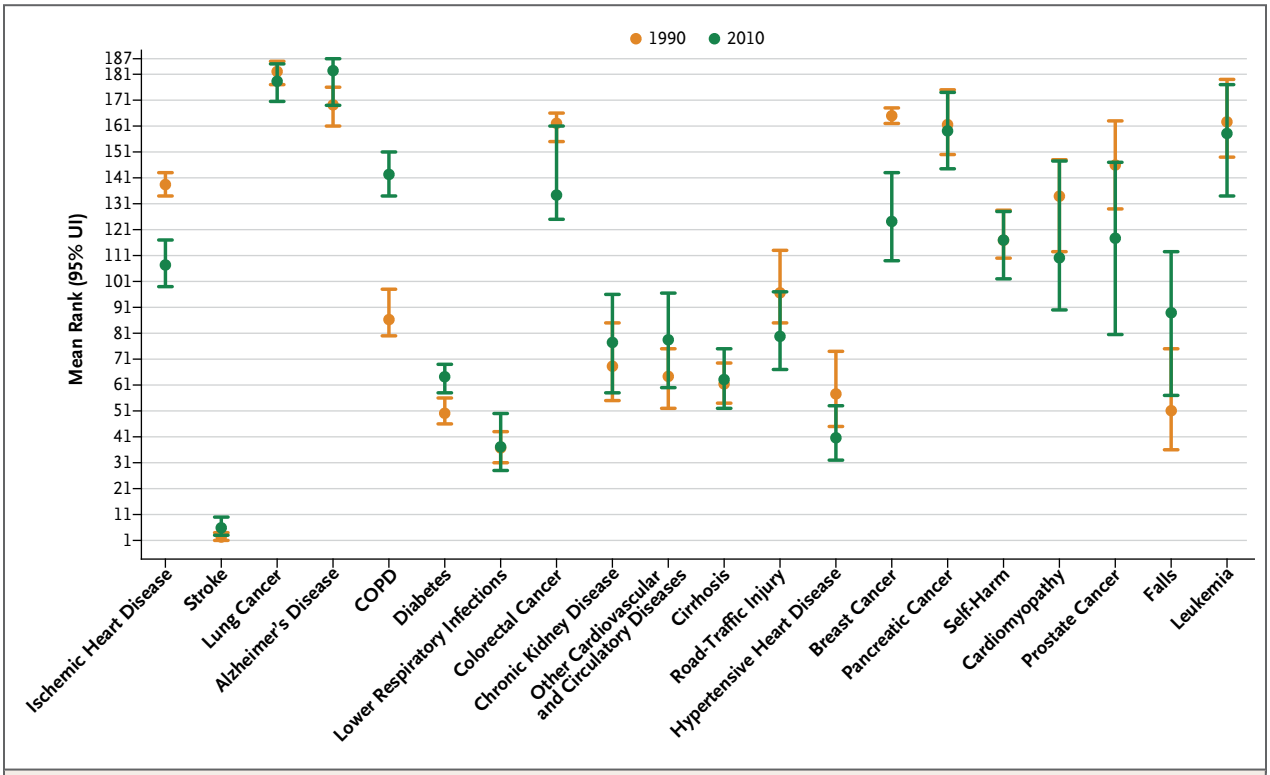

Figure 2. Age-Standardized Relative Rate of Death in the United States in 1990 and 2010, as Ranked among 187 Other Countries.

Ranks for the 20 leading causes of death in the United States are shown. Rank 1 is the lowest age-standardized mortality across the 187 countries, and rank 187 is the highest. I bars indicate 95% uncertainty intervals (UIs). COPD denotes chronic obstructive pulmonary disease.

and analyses are lacking to elucidate the drivers of these changes in relative performance, such as the contributions of medical care, public health, or trends in risk factors. Such benchmarking, however, provides a high-level synopsis of diseases for which the United States is achieving good outcomes and those for which it is not. Similar comparative assessments could be conducted within a country across units such as states or counties[28-34] to shed light on disparities.

FUTURE DEVELOPMENT

Quantifying the burden of disease provides useful input into health policy dialogues and identifies conditions and risk factors that may be relatively neglected and others for which progress is not what was expected. Nevertheless, estimates of disease burden can only improve as further data are collected and methods are refined. Going forward, we plan to release regular GBD study updates annually as new data or major new studies are released. With each revision, the entire time series from 1990 forward will be reassessed so that meaningful comparisons over time will be possible. Everyone — consumers, health professionals, researchers, and decision makers — will have access to assessments based on the latest available evidence. Continuous revisions will also facilitate the incorporation of scientific feedback on how to improve the estimation for any particular disease, injury, or risk factor in countries. With time, we hope that the definitions, methods, and estimation techniques from the GBD study effort will also be widely used to understand patterns of health within countries that are differentiated according to geographic region, social class, or race or ethnic group.

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

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