

## REVIEW ARTICLE

## GLOBAL HEALTH

## Noncommunicable Diseases

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THE UNITED NATIONS HAS HELD ONLY TWO MEETINGS OF HEADS OF STATE on a health-related issue. The first, in 2001, was on human immunodeficiency virus infection and the acquired immunodeficiency syndrome. The second, in September 2011, was on noncommunicable diseases. Although noncommunicable diseases were ignored during the framing of the Millennium Development Goals in 2000, their leading and growing contribution to preventable deaths and disability across the globe has compelled policymakers to pay attention and initiate action. The United Nations and the World Health Organization (WHO) have called for a 25% reduction by 2025 in mortality from noncommunicable diseases among persons between 30 and 70 years of age, in comparison with mortality in 2010, adopting the slogan “25 by 25.”<sup>1,2</sup> We review the burden of noncommunicable diseases and issues in prevention, detection, and treatment that must be addressed in order to meet this goal.

## DISEASE AND ECONOMIC BURDENS

## DISEASE BURDEN

Noncommunicable diseases have been a difficult group to define. Even the term “noncommunicable diseases” is a misnomer, because it includes some diseases — notably, cancers of the liver, stomach, and cervix — that are at least partly caused by infectious organisms, and it usually excludes mental illnesses, despite their large contribution to long-term disability. However, four common behavioral risk factors (tobacco use, excessive alcohol consumption, poor diet, and lack of physical activity) are associated with four disease clusters (cardiovascular diseases, cancers, chronic pulmonary diseases, and diabetes) that account for about 80% of deaths from noncommunicable diseases.<sup>3</sup> According to WHO estimates, noncommunicable diseases contributed to 36 million deaths globally in 2008, accounting for 63% of 57 million total deaths (Fig. 1).<sup>4</sup> The Global Burden of Diseases, Injuries, and Risk Factors Study 2010 (GBD 2010) estimated that mortality due to noncommunicable diseases (with the use of a somewhat different definition of noncommunicable diseases than that used by the WHO) increased from 57% of total mortality in 1990 to 65% in 2010.<sup>3,5</sup> About 80% of deaths related to noncommunicable diseases occur in low- and middle-income countries, which also have a high proportion of deaths in middle age; such countries account for 90% of the 9 million noncommunicable disease-related deaths that occur before 60 years of age (Fig. 2).<sup>6</sup> This staggering toll of noncommunicable diseases and premature mortality in low- and middle-income countries sometimes surprises those who suppose that mortality in these countries is still dominated by maternal and child deaths and deaths due to infectious diseases.

Cardiovascular diseases account for the largest fraction of deaths related to noncommunicable diseases, followed by cancer, chronic obstructive pulmonary disease (COPD), and diabetes (Fig. 3A and interactive graphic, available with the full text of this article at [NEJM.org](http://NEJM.org)).<sup>7</sup> Proportional mortality from noncommunicable diseases is



An interactive graphic showing the global burden of noncommunicable diseases over time is available at [NEJM.org](http://NEJM.org)

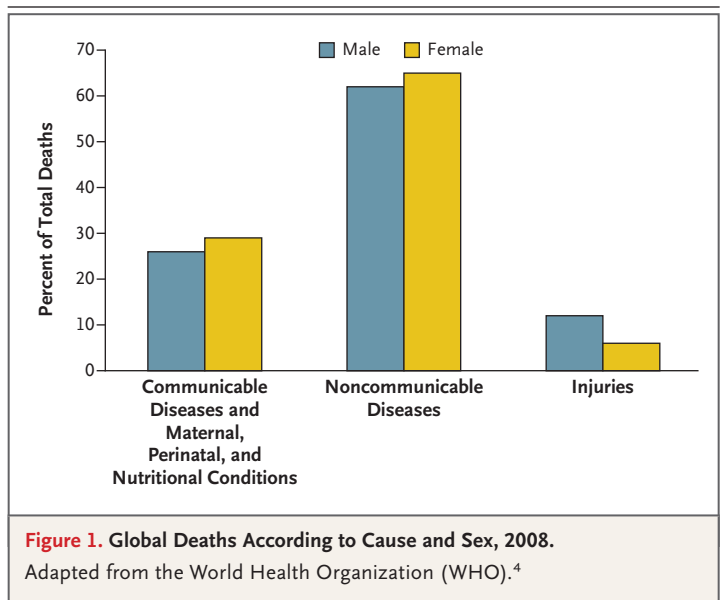
higher in high-income countries than in low- and middle-income countries, because high-income countries have a lower burden of maternal and child deaths and deaths due to infectious diseases. However, the absolute number of deaths due to noncommunicable diseases is higher in the low- and middle-income countries owing to their larger populations. Age-standardized rates of death due to noncommunicable diseases are also higher in these countries than in the high-income countries.<sup>8</sup>

The GBD 2010 also calculated disability-adjusted life-years (DALYs), which are the sum of years of life lost from premature death and years lived with disability, and estimated that 54% of DALYs worldwide in 2010 were due to noncommunicable diseases, an increase from 43% in 1990.<sup>7</sup> Between 1990 and 2010, DALYs due to cardiovascular diseases, cancer, and diabetes mellitus increased by 22.6%, 27.3%, and 69.0%, respectively, whereas DALYs due to COPD decreased by 2.0% (Fig. 3B). In addition, a large share of the burden of disability is due to other noncommunicable diseases, such as asthma, digestive diseases, neurologic disorders, mental and behavioral disorders, kidney diseases, gynecologic disorders, hemoglobinopathies, musculoskeletal disorders, congenital anomalies, and skin, sense-organ, and oral disorders. Whereas these diseases were associated with only 19.6% of deaths in 2010, they accounted for 54.8% of DALYs.<sup>7</sup> For some of these diseases, the primary risk factors are similar to those for cardiovascular disease, cancer, COPD, and diabetes, but for many the risk factors are specific and unique — a reminder that not all aspects of control of noncommunicable diseases are addressed by strategies targeted to the four major groups of noncommunicable diseases.

The WHO projects that noncommunicable diseases will account for an increasing absolute number and proportion of worldwide deaths, rising to about 70% of deaths in 2030.<sup>9</sup> The increase in the absolute numbers of deaths is primarily due to the increase in the size and age of the world population.

#### ECONOMIC EFFECTS

The economic consequences of noncommunicable diseases are huge, because of the combined burden of health care costs and lost economic productivity due to illness and premature deaths. A study commissioned by the World Economic Forum concluded that the world will sustain a

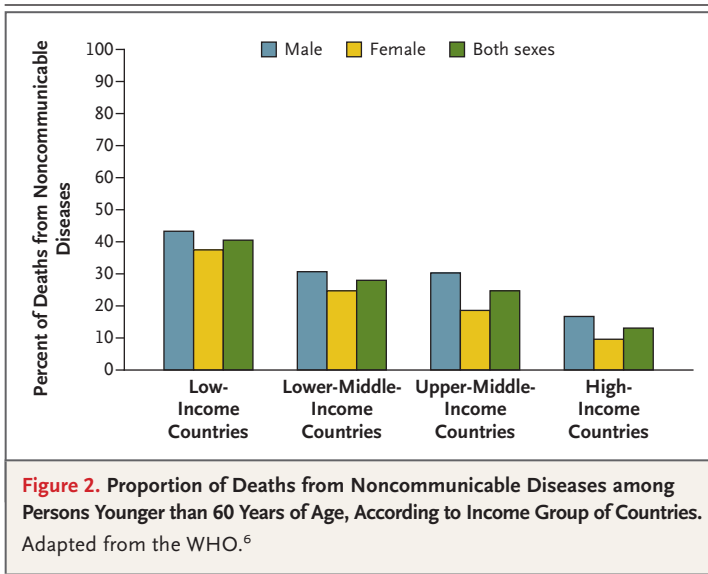


cumulative output loss of \$47 trillion between 2011 and 2030 because of noncommunicable diseases and mental illness, about \$30 trillion of which will be attributable to cardiovascular diseases, cancers, chronic pulmonary diseases, and diabetes.<sup>10</sup> Noncommunicable diseases are also a major cause of catastrophic health expenditure among the uninsured.<sup>11</sup>

#### PREVALENCE OF RISK FACTORS

Tobacco use, excessive alcohol consumption, poor diet, and lack of physical activity contribute to the development of noncommunicable diseases. Measurable phenotypes such as high blood pressure, hypercholesterolemia, and obesity mediate much of the relationship between these risk factors and the incidence of noncommunicable disease. As summarized in the review by Ezzati and Riboli,<sup>12</sup> global trends in the prevalence of these behavioral risk factors and intermediate phenotypes portend substantial increases in most of the noncommunicable diseases worldwide, with the patterns of change in incidence varying between and within regions, depending on the level of economic development, the pace of the demographic transition from high birth and death rates to low birth and death rates, and the prevalence of risk factors.<sup>12,13</sup>

Ethnic variations in susceptibility to disease have also been described, such as an increased risk of stroke in East Asian populations and an increased risk of coronary heart disease in South Asians.<sup>14,15</sup> Risk factors vary across regions. For



example, in South Asia, indoor air pollution due to burnt wood or biomass fuel at home is a major cause of COPD, and oral cancer is most often caused by chewed tobacco.

#### THE “UNFINISHED AGENDA” AND NONCOMMUNICABLE DISEASES

The term “unfinished agenda” is often used to refer to the health problems of less developed countries before the onset of the health transition — that is, mainly infectious diseases, malnutrition, and other diseases of poverty. In a cruel twist, some of the causes of noncommunicable diseases in these countries are due not to the behavioral risk factors listed above but rather to these “unfinished” problems. Heart disease due to rheumatic fever, for instance, is still a common cause of early-onset heart disease in low- and middle-income countries,<sup>16</sup> and the Barker hypothesis proposes that exposure to inadequate maternal nutrition in utero and during the first years of life increases the risk of noncommunicable diseases in adulthood.<sup>17</sup>

#### TRENDS IN HIGH-INCOME COUNTRIES

The rates of death due to noncommunicable diseases have peaked in some high-income countries, particularly with respect to cardiovascular diseases and some cancers, such as lung cancer. Figure 4 shows the 60-year trends in the United States, with age-adjusted rates of death from cardiovascular diseases decreasing by about 70%

since the 1950s, rates of death from cerebrovascular disease decreasing by 78% since the 1950s, and rates of death from cancer down by 17% since 1980.<sup>18</sup> Similar reductions in the rate of death from cardiovascular diseases and, among men, the rate of death from lung cancer have been seen in many high-income countries.<sup>13</sup> The sobering news is that despite these falls in the age-adjusted rates, the decline in the absolute number of deaths per year is much less substantial because of the growth and aging of the population. Thus, even if countries with growing and aging populations can engineer decreases in mortality, they will need to prepare for substantial numbers of cases of noncommunicable diseases. Worldwide, the GBD 2010 estimates of age- and sex-specific rates of deaths and DALYs due to noncommunicable diseases, as compared with rates in 1990, also show a substantial reduction in incidence rates, but these reductions are more than canceled out by increasing population size and population aging.<sup>3,7</sup>

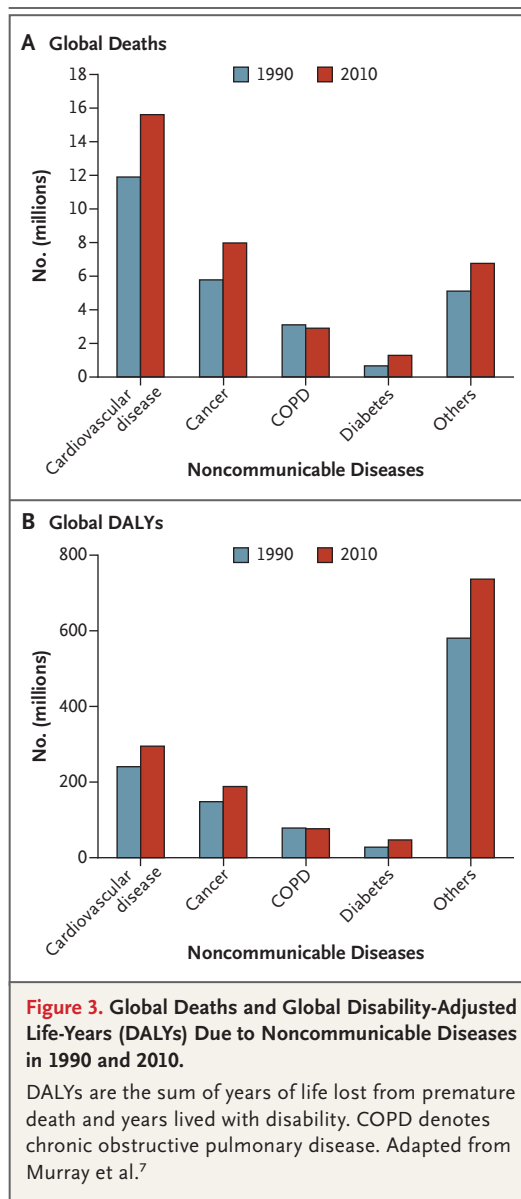
Modeling suggests that risk-factor reduction explains approximately 44 to 76% of the decline in mortality from coronary heart disease in the United States and other high-income countries, and improvements in treatments and access to treatments explain 23 to 47%.<sup>19</sup> During the 20th century, mortality from cervical cancer decreased dramatically in high-income countries, mainly because organized cervical screening led to early detection and treatment.<sup>20</sup> Lung-cancer rates are dropping as a result of declines in the prevalence of smoking. Thus, trends in high-income countries suggest that the size of the epidemic of noncommunicable diseases is not predetermined, and the challenge for low- and middle-income countries is to intervene sufficiently early to mitigate the epidemic.

#### STRATEGIES FOR PREVENTION AND CONTROL

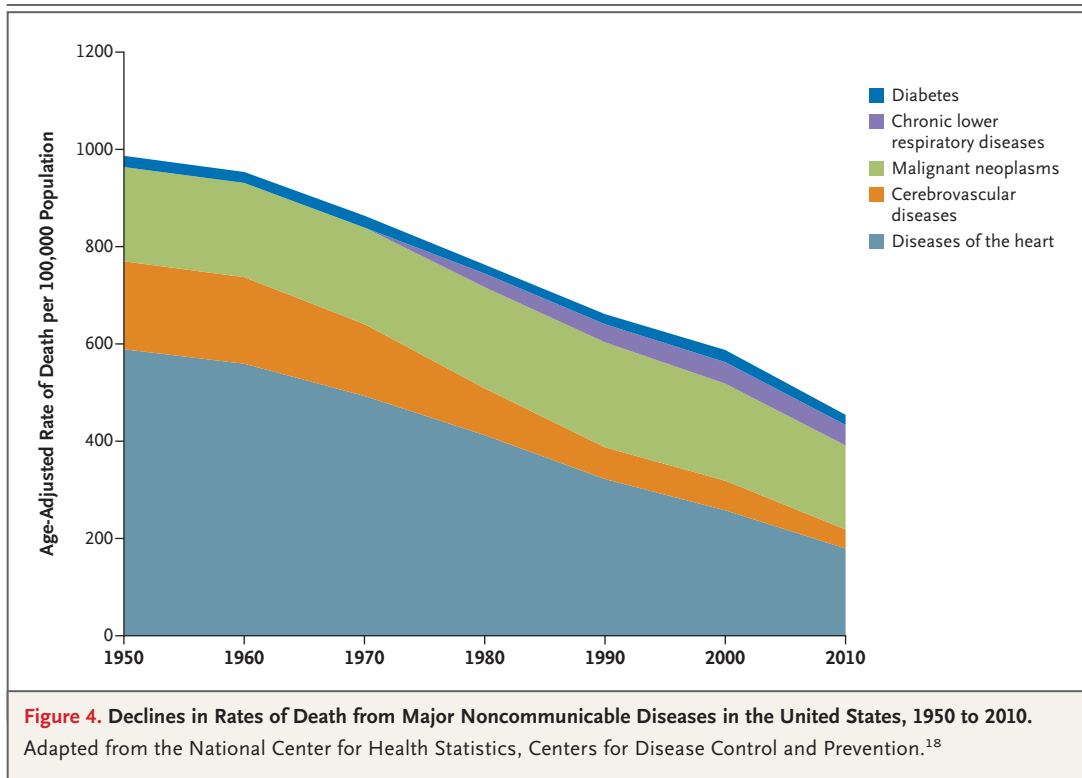
To be comprehensive, a program for the prevention and control of noncommunicable diseases must integrate policies designed to foster a societal environment in which people are encouraged to make and maintain healthy living choices, promote health literacy so that people can protect and improve their health, and provide health services focused on early detection and cost-effective management of noncommunicable diseases and their risk factors (Table 1).

Population-based interventions include policy measures such as increasing taxation of tobacco and alcohol, reducing salt and saturated fat and eliminating trans fats in processed foods, and creating smoke-free and exercise-friendly public spaces. Among the risk factors identified as major causes of noncommunicable diseases,<sup>13</sup> dietary risk factors and physical inactivity are partially determined by individual preferences but are substantially influenced by the manufacturing and marketing practices of the food industry and by the built and social environments that permit or impede physical activity. Evidence is rapidly accumulating that the consumption of sugared beverages is an important cause of childhood obesity, and in randomized trials, the substitution of lower-calorie beverages is associated with weight loss.<sup>21,22</sup> Mass-media messaging as well as health promotion in specific settings (schools, workplaces, and community centers) may be used to provide health education. Preventive interventions include risk-factor assessment and treatment with behavioral interventions and medication for persons at high risk. Although multidrug therapy for persons with established cardiovascular disease is required for secondary prevention, there is also a need to treat persons at high absolute risk for a first serious cardiovascular event. Some evidence-based therapies, such as the administration of generic antihypertensive agents and statins, are low-cost by the standards of high-income countries but are prescribed in low- and middle-income countries for only a small fraction of patients who are candidates for such treatment according to evidence-based guidelines, even though high blood pressure is the leading cause of deaths and DALYs.<sup>13</sup> Similarly, there is underutilization of therapies for secondary prevention of recurrent events — for example, after a myocardial infarction or cerebrovascular event. The development of combination pills (one form of which is called the “polypill”) has now entered the clinical-trial phase and holds promise for a simplified regimen at even lower cost.<sup>23,24</sup>

Tobacco is the second largest cause of deaths and DALYs worldwide, and tobacco control could prevent about a third of all deaths from cancer in the United States<sup>25</sup> and could also rapidly reduce deaths from cardiovascular and chronic pulmonary diseases. The WHO Framework Convention on Tobacco Control provides proven tobacco-control strategies that need to be



implemented within and between nations.<sup>26,27</sup> Public-interest litigation and changes in national laws such as the U.S. Tobacco Control Act<sup>28</sup> to provide greater government regulation of the tobacco industry are needed. Increasing obesity rates presage an increase in mortality from a wide variety of cancers<sup>29</sup>; thus, obesity prevention is a priority for cancer prevention, as well as for the prevention of cardiovascular disease and diabetes. In countries with infant vaccination against hepatitis B virus, chronic-carrier rates and rates of liver cancer have declined sharply.<sup>30</sup> The recent development of human papillomavirus vaccines for cervical-cancer prevention offers



a new opportunity to control the fourth leading cause of cancer deaths in women worldwide.<sup>31</sup> Many cancers are highly treatable, if detected early, and the provision of evidence-based screening and treatment regimens in low- and middle-income countries is an important component of cancer control that requires larger investments in human and capital resources.<sup>32</sup>

Many of these interventions have been identified as cost-effective by the WHO.<sup>33</sup> A series of “best buys,” determined on the basis of cost-effectiveness and the feasibility of implementation, have been suggested. For risk-factor reduction, these include tobacco and alcohol taxes, advertising bans and warnings, reductions in salt and trans fat intakes, promotion of physical activity, and hepatitis B vaccination. Health care “best buy” interventions include counseling regarding risk-factor reduction and multidrug therapy for persons at high risk for cardiovascular disease or diabetes, aspirin therapy for those with a history of acute myocardial infarction, and cervical-cancer screening and treatment. These interventions require a complex series of legislative actions, public-awareness campaigns, and public health interventions, as well as adequate numbers of clinical personnel, at least basic

clinical facilities, and adequate supplies of drugs. Bloom et al.<sup>10</sup> conclude, “Interventions in this area will undeniably be costly. But inaction is likely to be far more costly.”

#### CHALLENGES TO HEALTH SYSTEMS

The global epidemic of noncommunicable diseases poses challenges to the health systems of all countries, though the problems vary. High-income countries are confronted by the rising costs of technology-intensive health care for aging populations. The health systems of low- and middle-income countries must address the simultaneous challenges of multiple infectious diseases, undernutrition, and ongoing substandard maternal and child health, which vie with noncommunicable diseases for scarce financial and human resources. These problems are compounded by weak disease and risk-factor surveillance systems and lack of access to affordable drugs and laboratory and diagnostic tests.

In low- and middle-income countries, financial protection from the costs of treatment for noncommunicable diseases, in the form of public financing or insurance, is limited. The health care infrastructure is also limited, with inade-

**Table 1. Opportunities for Prevention, Detection, and Treatment of Noncommunicable Diseases in Low- and Middle-Income Countries.**

Level of Approach	Prevention	Detection	Treatment
Government	Anti-tobacco policy; policies that promote reduction in salt intake; regulation and labeling of processed foods and high-sugar beverages; planning for safe, healthy environments that promote physical activity and limit the transition to a sedentary lifestyle; policies designed to mitigate the harmful effects of alcoholic beverages	Promotion of awareness of noncommunicable diseases, their signs and symptoms, and the need for early detection	Policies that ensure access to affordable essential medicines
Health care system	Intersectoral planning for health promotion; training of health personnel, including task shifting for detection and treatment of noncommunicable diseases (e.g., blood-pressure and glycemic control provided by nurses or ancillary health workers)	Surveillance to determine the prevalence of risk factors and noncommunicable diseases; facilities and equipment for low-cost detection of intermediate risk factors (e.g., high blood pressure)	Facilities and equipment for affordable treatments; recognition of the need for both short-term and long-term treatment of noncommunicable diseases
Clinicians	Counseling of patients in risk-factor reduction; treatment of tobacco addiction	Evaluation of intermediate risk factors, coupled with lifestyle and drug interventions to lower risk-factor profiles; appropriate screening (e.g., detection of human papillomavirus)	Evidence-based treatment with affordable essential medicines; procedural or surgical interventions, if appropriate

quate facilities for advanced care and shortages of trained medical specialists, nurses, and allied health workers. Paradoxically, some low- and middle-income countries have highly advanced tertiary clinical care facilities in major cities, staffed by very skilled professionals. However, even in such countries, the diagnosis and treatment of noncommunicable diseases are usually very deficient at the primary and secondary care levels. In general, the health systems are configured to provide episodic care for acute illness and have not yet made the adaptations required to provide continuous care for chronic illness.

Access to essential drugs is not ensured in many countries, with inadequate supplies of cardiovascular drugs, anticancer agents, insulin and oral hypoglycemic agents, and bronchodilators.<sup>34</sup> An analysis of WHO data from 36 countries showed that the availability of cardiovascular drugs was poor (26.3% of public-sector facilities and 57.3% of private-sector facilities had such drugs),<sup>35</sup> and a survey of 6 countries by the WHO showed that the monthly cost of treatment with a single antihypertensive medication exceeded several days' wages in many countries.<sup>36</sup> When multiple drugs are used, the cost becomes unaffordable, and this problem is further compounded when more than one family member needs treatment.<sup>36</sup> In low- and middle-income countries, drug therapy for cardiovascular disease is a major contributor to high out-of-

pocket health care expenditures, resulting in millions of people being pushed into poverty. Countries such as Thailand and India are resorting to compulsory licensing to domestically produce the more expensive cardiovascular or anticancer drugs. Lack of reform of national and international regulations on opiate production and export means that many patients with cancer are deprived of low-cost drugs such as morphine that could provide pain relief.<sup>37</sup>

At the same time, the reduced cost of care for many procedures, such as cardiac or cancer surgery, in developing countries is opening up markets in medical tourism. Even as low- and middle-income countries can gain from access to technical expertise in high-income countries, the latter can learn from the highly cost-efficient and high-throughput models of surgery developed in some low- and middle-income countries<sup>38</sup> and new, lower-cost technologies developed under the rubric of "frugal innovation."<sup>39</sup>

In primary health care, there is a need to train and deploy nonphysician health care workers, ranging from community health workers to skilled nurses, while enhancing the ability of primary care physicians to provide appropriate care based on standard guidelines. The ability of nonphysician health workers to effectively detect and manage diabetes and high blood pressure has been shown in countries such as South Africa<sup>40</sup> and Iran.<sup>41</sup> The WHO Cardiovascular Risk Management Package has been shown to be use-

ful for scaling up the management of cardiovascular diseases in primary health care settings in which physicians are not available.<sup>42</sup>

Cell phone–based “mHealth” tools have been successfully used by frontline health care workers for remote data collection, remote monitoring, and diagnostic and treatment support in several developing countries.<sup>43</sup> Further extending these applications with regard to noncommunicable diseases could also be promising, as shown in formative research on diabetes care in developed nations.<sup>44</sup> Information and communication technology can enable nonphysician health care providers to play an effective role in the diagnosis and management of noncommunicable diseases.

Progress toward the goal of a 25% reduction in the rate of premature death from noncommunicable diseases by 2025 will require both country-specific actions and global cooperation.<sup>45</sup> Country-specific actions require strong political leadership and the development of national action plans that mobilize a multisectoral response (e.g., multiple levels of government, the private sector, and nongovernmental organizations) and provide mechanisms to monitor progress and ensure accountability from the multiple sectors involved. Brazil, for instance, passed a new anti-tobacco law, signed agreements with the food industry to reduce salt consumption and eliminate trans fats from processed foods, and improved access to cardiovascular drugs.<sup>45</sup> Global cooperation is needed, given the globalization of tobacco exportation and agribusiness and multinational ownership of major food and soft-drink manufacturers.

The importance of addressing noncommunicable diseases at the global level has also become a major element of the ongoing discussion concerning the post-2015 development goals, which is being steered by the United Nations. Whereas non-

communicable diseases were omitted from the Millennium Development Goals in 2000, a consensus is emerging among the various United Nations agencies and other international organizations that a life-course perspective must be adopted, with an emphasis on noncommunicable diseases as part of the health goal to be included in the set of post-2015 Sustainable Development Goals. Whether the goal itself will be defined as “Gaining Health and Well-Being at All Stages of Life” or “Maximizing Healthy Life Expectancy” or “Universal Health Coverage”<sup>46</sup> (which are leading contenders at present), it is clear that the prevention and control of noncommunicable diseases will be acknowledged as an integral part of the sustainable-development agenda. However, it remains to be seen whether the plan of action will address the many upstream determinants of noncommunicable diseases, going beyond the needed clinical services.<sup>47</sup>

## CONCLUSIONS

Noncommunicable diseases will be the predominant global public health challenge of the 21st century. Prevention of premature deaths due to noncommunicable diseases and reduction of related health care costs will be the main goals of health policy. Improving the detection and treatment of noncommunicable diseases and preventing complications and catastrophic events will be the major goals of clinical medicine. A multilevel approach that integrates policy actions, regulations, health education, and efficient health systems to achieve these goals will be the mission of public health. All countries can benefit by sharing experience and pooling expertise for the prevention and control of noncommunicable diseases.

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

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