Chronic Diseases 1

The burden and costs of chronic diseases in low-income and middle-income countries

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This paper estimates the disease burden and loss of economic output associated with chronic diseases—mainly cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes—in 23 selected countries which account for around 80% of the total burden of chronic disease mortality in developing countries. In these 23 selected low-income and middle-income countries, chronic diseases were responsible for 50% of the total disease burden in 2005. For 15 of the selected countries where death registration data are available, the estimated age-standardised death rates for chronic diseases in 2005 were 54% higher for men and 86% higher for women than those for men and women in high-income countries. If nothing is done to reduce the risk of chronic diseases, an estimated US$84 billion of economic production will be lost from heart disease, stroke, and diabetes alone in these 23 countries between 2006 and 2015. Achievement of a global goal for chronic disease prevention and control—an additional 2% yearly reduction in chronic disease death rates over the next 10 years—would avert 24 million deaths in these countries, and would save an estimated $8 billion, which is almost 10% of the projected loss in national income over the next 10 years.

Introduction

In 2005, WHO re-emphasised the importance of chronic (non-communicable) diseases as a neglected global health issue.[1] Chronic diseases—mainly cardiovascular disease, cancer, chronic respiratory diseases, and diabetes—were estimated to cause more than 60% (35 million) of all deaths in 2005; more than 80% of these deaths occurred in low-income and middle-income countries. We previously projected that, in 2015, 41 million people will die from chronic diseases without concerted prevention and control action.[2] Achievement of the global goal of reducing chronic disease death rates by an additional 2% every year would avert 36 million deaths between 2005 and 2015.

Most of these averted deaths will be in low-income and middle-income countries, and just less than half will be in people younger than 70 years.[2] Moreover, in most countries the poorest people have the highest risk of developing chronic disease and they are least able to cope with the resulting financial consequences.[3] When the costs to individuals are summed, the loss to the economy can be substantial. For example, one study for the UK[4] suggested that a total of £1·7 billion (about US$3 billion) was spent on prevention or treatment of heart disease in 1999. The investigators argued that people who were ill lost £2·9 billion (about $5·2 billion) in potential earnings, and they valued the time spent by informal carers at a further £2·4 billion (roughly $4·3 billion).[4]

Although there are now many estimates of the economic effects of different types of chronic diseases, they are not directly comparable because inconsistent methods are used and because different societies have different ways of delivering and financing health services, which directly impinge on costs.[5–10] Accordingly, the overall objective of this Series is to assess more accurately the effect of chronic diseases on health and economic wellbeing with consistent methods, and to provide empirical evidence for possible strategies to reduce their harmful effects, to support low-income and middle-income countries as they respond to the chronic disease epidemics.

In the first paper in this Series, we estimate the burden and loss of economic output associated with chronic diseases in 23 selected countries (figure 1). These countries were selected as leading countries collectively accounting for around 80% of the total mortality burden attributable to chronic diseases in developing countries. We summarise the latest projections of the effect of chronic diseases on mortality in low-income and middle-income countries, focusing on these 23 countries.

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Key messages

- In 23 selected countries, which account for around 80% of the total chronic disease mortality burden in developing countries, chronic diseases are responsible for 50% of the total disease burden

- Age-standardised death rates for chronic diseases are more than 50% higher in the 15 of these countries with death registration data than in high-income countries

- If nothing is done to reduce risk of chronic diseases, an estimated US$84 billion of national income will be lost from heart disease, stroke, and diabetes alone in the 23 selected countries between 2006 and 2015

- As little as a 2% yearly additional reduction in mortality rates from chronic diseases would avert 24 million deaths, with almost 80% of the life-years gained coming from deaths averted in people younger than 70 years, and save almost 10% of the expected loss in income and around $8 billion collectively for the 23 countries by 2015

- Governments have a key role in stimulating the generation of information to reduce the risk of chronic diseases and in ensuring access to preventive and treatment services, especially for poor people
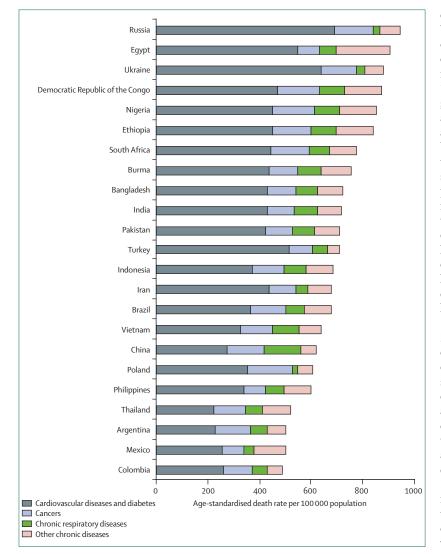
Figure 1: Projected age-standardised death rates for 2005 from chronic diseases (per 100 000), for all ages and both sexes in 23 selected countries

We then estimate the effect of premature deaths from chronic diseases on the countries' national income, which is measured in gross domestic product (GDP) losses per working-age population. We aggregate estimates from coronary heart disease, stroke, and diabetes, since these disorders represent the greatest burden of the entire group of chronic diseases. All estimates are projected between 2005 and 2015. Finally, we estimate potential gains in GDP that are achievable through meeting the global goal of a 2% additional yearly reduction in mortality rates from chronic diseases.

Global epidemiology and burden of chronic diseases

WHO has undertaken a progressive reassessment of the Global Burden of Disease (GBD) study for 2000–02, with consecutive revisions and updates published yearly in WHO World Health Reports.[11] These updates make use of a wide variety of data sources to develop internally consistent estimates of incidence, severity, duration, and mortality for more than 130 major causes, for 14 subregions of the world. The methods we use here are generally similar to those of the original GBD study, albeit with substantial improvements in data availability and some new methods for dealing with incomplete and biased data.[12,13] The burden of disease is quantified in terms of disability-adjusted life-years (DALYs), which is a summary measure that combines years of life lost due to premature death and years of life lived with disability—ie, in states of less than full health. One DALY can be thought of as 1 lost year of healthy life, and the burden of disease as a measurement of the gap between the present health of a population and an ideal situation in which everyone in the population lives into old age in full health.[13] The DALYs reported here use 3% time discounting and non-uniform age weights, which give less weight to years lived at younger and older ages.

Data for death registration were available for 15 of the 23 selected countries. For India and China, data were obtained from urban death registrations together with data based on verbal autopsies from representative sample registration systems for rural areas. For the other eight countries, five in Asia and three in Africa, deaths by age, sex, and cause were estimated by use of available country-specific data for levels of all-cause mortality, together with improved cause-of-death models based on a dataset of 1613 country-years of cause-of-death distributions from 58 countries between 1950 and 2001.[14] Population-based epidemiological studies, disease registers, and notifications systems also contributed to the estimation of mortality due to 21 specific causes of death, including HIV/AIDS, tuberculosis, malaria, vaccine-preventable diseases, and cancers.[13]

To quantify incidence, prevalence, and severity of disorders for calculation of the years lived with disability component of the DALY, around 8700 datasets were used, about a quarter of which (2100) were related to chronic diseases. Around 60% of these datasets related to populations in low-income and middle-income countries. Methods and data sources for specific chronic diseases are described in more detail elsewhere.[13]

We used the projection methods described below to project the 2002 mortality and burden of disease estimates to the year 2005. Globally, we estimated that roughly 58 million people died in 2005, and that 60% of these deaths were caused by chronic diseases—principally, cardiovascular diseases and diabetes (32%), cancers (13%), and chronic respiratory diseases (7%). 80% of worldwide deaths from chronic diseases occurred in low-income and middle-income countries, and 80% of these deaths occurred in the 23 selected countries. Deaths from chronic disease in people younger than 70 years accounted for 48% of all chronic disease deaths in the 23 selected

	2005	2015	2030
Deaths (all ages)			
CVD and diabetes	12·4 (33%)	14·3 (35%)	17·3 (36%)
Cancers	4·5 (12%)	5·6 (14%)	7·5 (15%)
Chronic respiratory	3·1 (8%)	4·1 (10%)	5·9 (12%)
All chronic diseases	23·1 (61%)	27·2 (66%)	34·3 (71%)
Deaths in people younger than 70 years			
CVD and diabetes	5·2 (21%)	5·6 (23%)	5·9 (23%)
Cancers	2·8 (12%)	3·4 (14%)	4·1 (16%)
Chronic respiratory	1·1 (5%)	1·4 (6%)	1·9 (7%)
All chronic diseases	11·2 (46%)	12·4 (50%)	13·7 (53%)
DALYs			
CVD and diabetes	121 (12%)	131 (13%)	145 (14%)
Cancers	51 (5%)	59 (6%)	71 (7%)
Chronic respiratory	42 (4%)	49 (5%)	62 (6%)
All chronic diseases	496 (50%)	538 (55%)	597 (59%)

CVD=cardiovascular disease. DALYs=disability-adjusted life-years.

Table 1: Millions of projected deaths and DALYs for chronic diseases as a proportion of deaths and DALYs for all causes in 23 selected countries for 2005, 2015, and 2030

countries. In terms of burden of disease, measured in DALYs, chronic diseases were responsible for an estimated 49% of the total worldwide burden of disease in 2005 and 46% of the disease burden in low-income and middle-income countries. Cardiovascular diseases (including coronary heart disease and stroke) and diabetes mellitus were responsible for 12% of the total burden of disease, and cancers and chronic respiratory diseases for an additional 9%. In the 23 selected low-income and middle-income countries, chronic diseases were responsible for 50% of their total disease burden in 2005 (table 1).

Age-specific deaths rates for chronic disease are higher in many low-income and middle-income countries than in high-income countries. For the 15 selected countries with death registration data for causes of death, the overall age-standardised death rates for chronic diseases were 769 per 100 000 for men and 602 per 100 000 for women. These rates are 54% and 86% higher, respectively, than those for men and women in high-income countries in 2005. In the 23 countries shown in figure 1, age-standardised death rates for chronic diseases are highest in some eastern European countries such as Russia and Ukraine, and in some African countries such as Egypt, Nigeria, and South Africa. Sex differences in age-standardised death rates are highest in the eastern European countries, because of especially high rates of cardiovascular disease mortality in men. Death rates for chronic respiratory disease are highest in China.

Substantial uncertainty remains about the comparative burden of diseases and injuries in many parts of the world, especially for regions with few data for death registration. The GBD approach included results for these regions, albeit with wider uncertainty ranges, on the basis of the best possible assessment of the available evidence. Uncertainty in estimates of death rates for chronic disease are much higher for countries with incomplete or sample data for death registration, and for countries without useable death registration data, than they are for those with death registration. The 95% uncertainty intervals for cardio-vascular disease mortality in 2001 are estimated to range from around 12% in developed countries, to 18% in east Asia and the Pacific region, and 30% in sub-Saharan Africa.[15]

Projections of mortality for 2015 and 2030

We used a set of fairly simple models to project future mortality and burden of disease trends, based largely on projections of economic and social development, and using the historically observed relations between these projections and cause-specific mortality rates, as well as including including updated projections for HIV/AIDS and the tobacco-related epidemic.[16] For the projections reported here, historical data for death registration for 107 countries between 1950 and 2002 were used to model the relation between death rates for all major causes (excluding HIV/AIDS, tuberculosis, and diabetes) and the following variables: average income per head; the average number of years of schooling for adults; smoking impact (a measure of mortality from lung cancer attributable to tobacco); and time, which is a proxy measure for the effect of technological change on health status. We then projected death rates with World Bank estimates of income per head and WHO projections of average years of schooling and smoking intensity. Separate projections were done for HIV/AIDS, tuberculosis, and diabetes under specific scenarios for the scale-up of antiretroviral drug treatment coverage, the scale-up of control activities for tuberculosis, and trends in overweight and obesity.[16]

We also used mortality projections as the basis for projections of the global burden of disease from 2002 to 2030. For coronary heart disease and stroke projections, incidence was assumed to decrease at half the rate predicted for mortality—ie, projected trends in mortality were assumed to be equally due to changes in incidence (reflecting changes in risk factor exposures and prevention activities) and changes in case-fatality rates (reflecting improvement of treatment effectiveness).

According to the projection model, age-specific death rates for most chronic diseases are projected to decrease slightly at rates of around 0·5–1·0% per year, with the exceptions of lung cancer and chronic obstructive pulmonary disease (which are increasing because of the tobacco epidemic) and diabetes mellitus (which is increasing because of projected increases in the prevalence of overweight and obesity). These falling death rates are a result of the observed decreases in age-specific death rates for chronic disease with increasing levels of development in the available death registration data for 107 countries between 1950 and 2002. Adverse trends for some chronic disease risk factors such
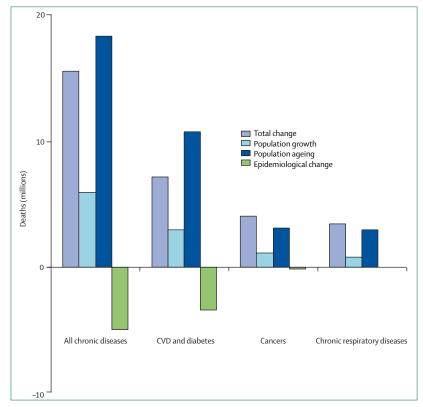
Figure 2: Decomposition of projected change in numbers of chronic disease deaths into demographic and epidemiological components, in 23 selected countries, 2005–30

CVD=cardiovascular disease. The difference between the total change in numbers of deaths from 2005 to 2030 and the sum of the demographic and epidemiological components is due to the interaction between demographic and epidemiological components.
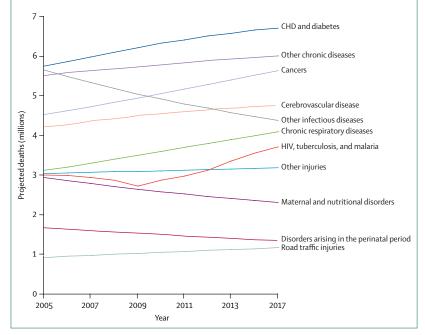

Figure 3: Projected global deaths (millions) for major chronic disease groups and other causes of death in 23 selected countries, 2005–15

CHD=coronary heart disease.

as overweight and physical inactivity were probably more than offset in these countries by improved control of other risk factors such as high blood pressure, high blood cholesterol, and tobacco smoking, and improved access to effective treatment interventions.

Because mortality risks are strongly age-dependent for most chronic diseases, changes in the projected age structure of populations could result in substantial changes in the number of deaths, even when the age-specific risks remain unchanged or are decreasing slowly. On the basis of Mathers and Loncar's methods,[16] we analysed the contribution of demographic and epidemiological change to the projected numbers of deaths from chronic disease by cause for the selected 23 countries. Epidemiological change refers to the projected trends in age-specific mortality rates. For chronic diseases, population growth and ageing are the major causes of growth in projected numbers of deaths (figure 2).

Total deaths from chronic disease for the 23 selected countries are projected to rise to 27·2 million in 2015 and 34·3 million in 2030 (table 1). Just under half of these deaths will occur in people younger than 70 years, compared with only 27% in high-income countries. The proportion of deaths attributable to chronic diseases in people younger than 70 years in these countries will rise to 53% by 2030, and the overall share of burden of disease in DALYs from 50% to 60%. Figure 3 shows the projected trends in total deaths for selected causes. Large decreases in both numbers of deaths and mortality rates are projected for most communicable disease causes with the exception of HIV/AIDS. Under the projection scenario involving scale-up of antiretroviral therapy coverage to 80% by 2012, but not additional prevention efforts, HIV/AIDS deaths for the 23 countries will increase from 1·6 million in 2002 to 2·7 million in 2015. Although age-specific death rates for most chronic diseases are projected to fall with increasing levels of economic development, ageing of the populations of these countries will substantially increase the total number of deaths.

We have used pessimistic and optimistic projections with alternative sets of input assumptions to estimate uncertainty rather than calculating confidence intervals. Projected chronic disease mortality is not highly sensitive to a reasonably broad range of assumptions about future economic growth and trends in the tobacco epidemic. With pessimistic and optimistic projection scenarios, projected chronic disease mortality in 2030 is expected to range from 48·5 million to 53·6 million worldwide.[16]

The mortality and burden of disease projections are less firm than are the base year assessments, and represent a vision of the probable future based on an explicit set of business-as-usual assumptions. They do not specifically account for trends in major risk factors apart from tobacco smoking, and to a small extent, overweight and obesity factors. The panel shows trends and projections for selected major risk factors in Brazil.[17–24] If risk factor exposures do not generally decrease with

economic development and with improvement of health systems in developing countries, then our projections of deaths and DALYs in low-income and middle-income countries might be underestimated.

Panel: Trends in chronic disease risk factors—the situation in Brazil

Over the past decade, substantially more data for the descriptive epidemiology of risk factors and chronic diseases have become available for several developing countries. When population-level data for risk factors are available for more than one point in time, an absence of comparability usually restricts its usefulness. The size and diversity of the world's largest countries adds another dimension to the challenge of finding nationally representative information. A good example is Brazil, which has been collecting data for major risk factors for chronic disease for a long time, with some studies extending back to 1975.

Tobacco use, obesity, and raised cholesterol are three risk factors for which comparable trend data are available for Brazil.[17-23] These data show that, although tobacco use has recently begun to decrease, obesity has been increasing steadily from the first measurements in 1975. Increasing prevalence of obesity has been accompanied by a rise in the number of people with measured total cholesterol values of 5·2 mmol/L or higher. The proportion of adults aged 15 years and older with raised total cholesterol greater than or equal to 5·2 mmol/L in Brazilian capital cities rose from 33% in 1995 to 40% in 2002. The healthy years of life gained by reductions in tobacco use are probably offset by the effect of rising obesity and cholesterol levels. Obesity is closely associated with diabetes type 2 and high blood pressure. Raised blood pressure and total cholesterol levels will lead to premature morbidity and death from cardiovascular diseases, especially stroke.

Chronic diseases were projected to account for 70·5% of total deaths in Brazil in 2005. Application of the methods of the WHO Comparative Risk Assessment Study[24] to mortality estimates for Brazil suggests that the four leading risk factor causes of death in 2005 were high blood pressure (20% of all deaths), high cholesterol (11%), tobacco (7·6%), and overweight and obesity (6·5%). WHO projections for Brazil suggest that obesity in men and women will continue to rise, and 12·4 % of men and 24·5% of women will be obese by 2015. These estimations have serious implications for prevalence of raised blood pressure, raised total cholesterol, and diabetes. Population mean systolic blood pressure for people aged 15 years or older is projected to be 123·7 mm Hg (SD 16·2) for men and 119·1 mm Hg (17·1) for women by 2015. Although not as visible as tobacco use or obesity, raised blood pressure and cholesterol levels will result in treatment costs to individuals, their families, and the government. Urgent action is needed to address these silent risks to healthy ageing before the need for treatment surpasses the ability to pay.

The macroeconomic effect of chronic diseases

The macroeconomic costs, or costs to a country as a whole, of chronic disease could be estimated in three ways: the accounting or cost-of-illness method, in which medical and non-medical costs as well as the monetary value of lost labour productivity because of illness or death is assessed and an attempt is made to sum-up across individuals; economic growth models, which assess the effect of chronic diseases on national income through changes in key inputs such as labour supply and savings; and the full-income method, which attempts to measure the societal value of welfare loss associated with ill-health or death in money terms, to be added to the loss of GDP. To our knowledge, all published studies on the costs of chronic diseases have used the cost-of-illness method.[4-10] The only other relevant analysis is a study using cross-country data for 1960 to 2000 to explore the relation between mortality from chronic diseases and income, accounting for other possible determinants of economic growth.[25]

Unsurprisingly, these different methods can result in substantial differences in findings and their interpretation. Estimates from the economic growth approach are often linked to GDP to provide a straightforward interpretation of the results, but they tend to produce the lowest effect. The full-income approach puts a monetary value on the welfare loss associated with the loss of human life, and is generally assumed to vary between 100 and 200 times the level of GDP per head. When added to the value of the production loss, the resulting estimate of the overall economic loss is very high. The cost-of-illness estimates fall between the two, but can result in misleading conclusions because, in addition to measuring medical and non-medical costs, these studies often also measure what is commonly called indirect costs or the lost production associated with the disease. This cost is usually rather simplistically assumed to be the total time lost through premature death and illness (mostly self-reported lost days, which overestimate true lost days) multiplied by a wage rate, and sometimes accounting for unemployment. This approach is incorrect for several reasons. For example, in developing countries with large work forces, a household member who cannot work because of illness is frequently replaced by other people in the family, with little loss in output. Every day of illness does not necessarily represent lost income or a loss to the economy. We, therefore, choose the more conservative approach and report estimates of the loss of GDP with use of an economic growth model.

These models are based on the observation that economic output, here measured in monetary terms, is produced by labour time, combined with capital inputs such as machines, land, etc. A mathematical relation between these inputs is developed in a way that is consistent with economic theory.[26,27] The webappendix provides details of the model we used.

Building on previous studies on the channels through which disease can affect economic growth,[28-35] we project

See **Online** for webappendix

	Baseline scenario				Cumulative GDP loss averted (US$billions) if global goal were achieved by 2015
	Foregone GDP (US$billions)			Cumulative GDP loss (US$billions) by 2015	
	2006	2015	2015 as proportion of 2006 estimates		
China	1·01	1·84	182%	13·81	1·36 (9·83%)
India	1·35	1·96	145%	16·68	1·64 (9·83%)
Russia	1·49	1·64	110%	16·09	1·49 (9·26%)
Brazil	0·33	0·50	150%	4·18	0·43 (10·23%)
Indonesia	0·33	0·53	158%	4·18	0·39 (9·33%)
Mexico	0·48	0·89	186%	7·14	0·75 (10·58%)
Turkey	0·39	0·52	133%	4·70	0·46 (9·72%)
Pakistan	0·15	0·21	140%	1·72	0·15 (8·62%)
Thailand	0·12	0·18	150%	1·49	0·15 (10·20%)
Bangladesh	0·08	0·14	175%	1·14	0·08 (7·14%)
Ukraine	0·13	0·13	100%	1·33	0·13 (9·43%)
Egypt	0·11	0·14	125%	1·26	0·11 (8·89%)
Argentina	0·13	0·16	125%	1·40	0·13 (9·09%)
Burma	0·03	0·06	200%	0·43	0·04 (9·09%)
Iran	0·08	0·13	167%	0·99	0·10 (10·53%)
Poland	0·17	0·23	133%	2·17	0·23 (10·53%)
South Africa	0·16	0·21	133%	1·88	0·21 (11·43%)
Philippines	0·06	0·07	133%	0·62	0·06 (9·09%)
Colombia	0·07	0·10	150%	0·82	0·07 (8·33%)
Vietnam	0·02	0·03	200%	0·27	0·03 (12·50%)
Nigeria	0·12	0·12	100%	1·17	0·12 (10·00%)
Ethiopia	0·03	0·03	100%	0·16	0·01 (7·50%)
Democratic Republic of the Congo	0·00	0·03	140%	0·15	0·01 (7·90%)
Total	6·8	9·8	1·5	83·8	8·1 (9·5%)

GDP=gross domestic product.

Table 2: Projected foregone national income due to heart disease, stroke, and diabetes, and cumulative GDP gains through achievement of a global goal of an additional 2% annual reduction in mortality due to chronic diseases, 2006–15

the long-term economic effect of chronic diseases between 2005 and 2015 for all 23 countries on the basis of the following scenario. We compare GDP levels if there were no deaths from chronic diseases (the counterfactual) with a scenario in which historical trends of increasing coverage of treatment and prevention services to reduce chronic diseases were maintained untill 2015 (ie, the baseline scenario).

To estimate the model, we needed information about the available data for labour input, the capital stock, and the rate of change of both. Labour inputs were obtained from projected population estimates and mortality rates from chronic diseases taken from the analysis reported above. Capital stock and its rate of growth were obtained from Easterly and Levine.[36] Since we had no reliable data for the extent to which health expenditures are financed from

saving, which provides information about the effect of chronic diseases on investment possibilities, we used 10% as a conservative assumption that was varied between 0% and 25% in sensitivity analysis. The baseline scenario has a lower rate of capital accumulation than does the counterfactual scenario because health spending reduces savings and, therefore, investment. The size of the population aged 15–64 years was used as the indicator of the labour force, since other parameters used in the model were based on studies that had made the same assumption. The other parameters relate to the (marginal) productivity of capital and labour as well as the effect of technological change on economic growth. The webappendix provides sources of these data and the way that they were combined to produce the estimates of GDP.

In 2006, the estimated losses because of coronary heart disease, stroke, and diabetes (reported in 2005) ranged from $20–30 million in Ethiopia and Vietnam to almost $1 billion in larger countries such as China and India (table 2). In most countries, these estimates almost double if no preventive action is taken up to 2015 (baseline scenario). The accumulated losses in GDP between 2006 and 2015 can be as much as $14 in China and $17 billion in India, representing a loss of around 0·1% of their projected GDP for this period. This amount is substantial considering that we have not included all chronic diseases in this analysis.

All 23 countries combined risk losing $84 billion in economic output in 2006–15 from coronary heart disease, stroke, and diabetes alone.

Potential gains achievable through meeting the global goal

In 2005, to encourage action to prevent chronic diseases, WHO proposed a global goal for reduction of deaths and burden of disease due to chronic disease, which specified an additional 2% yearly decrease in projected age-specific death rates from chronic diseases worldwide.[2] Projected yearly rates of change in age-specific and sex-specific death rates for all chronic disease causes were calculated for the mortality projections from 2006 to 2015 and then adjusted by subtraction of an additional 2% per year. Death rates were then recalculated with the adjusted yearly trends for age-sex-specific rates. Population numbers were projected with use of the new death rates under the global goal scenario. Years of life gained under the global goal scenario were estimated by calculation of total years of life lost (without discounting or age weights) for every year from 2006 to 2015 under the global goal scenario and subtracting these years lost from those lost under the base projections scenario.

When this global goal was first proposed, 36 million fewer deaths were predicted between 2005 and 2015 globally. This figure equates to a cumulative benefit of 648 million life-years saved between 2005 and 2015, 500 million (77%) of which were from deaths averted in people younger than 70 years and 370 million (57%) in
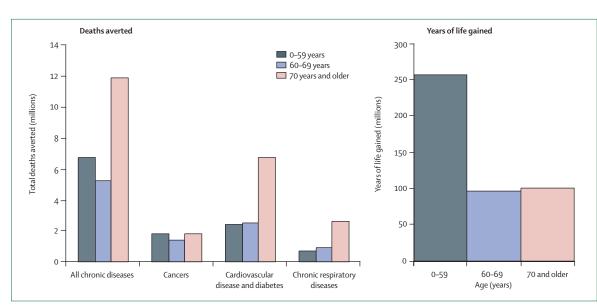
Figure 4: Cumulative deaths averted and years of life gained by an additional 2% annual reduction in chronic death rates in 23 selected countries, 2006–15

those younger than 60 years.[2] Achievement of the same mortality reduction in the 23 selected countries would result in 24 million fewer deaths from chronic diseases in the same period, and 454 million years of life gained (figure 4). Because the estimates of deaths averted and life years gained under the global goal scenario are calculated from the difference between two projection scenarios, the uncertainty around these estimates is lower than it is for the projections themselves.

How realistic is the global goal proposal? Under the baseline projections, chronic disease death rates for the 0–59 and 60–69 year age groups are predicted to fall by an average annual 0·3% and 1·2%, respectively, for the 23 selected countries. Therefore the global goal would correspond to an annual average reduction of 2·3% for 0–59 year age group, and 3·2% for the 60–69 year age group between 2005 and 2015.

The experience of some high-income and middle-income countries clearly shows what can be achieved with sustained interventions. Analysis of death registration data reported to WHO shows that chronic disease death rates for the 0–59 year age group in the 1990s decreased by a yearly average greater than 2% in El Salvador, Germany (men), Guatemala (women), Hong Kong, Italy (men), South Korea, Panama, Puerto Rico (men), and Singapore. For the 60–69 year age group, average yearly decreases in chronic disease death rates exceeded 3% for several populations, including Australia, Austria, the Czech Republic, El Salvador (women), Finland, Germany (men), Hong Kong, Ireland (men), Italy (men), the South Korea, Norway (men), Singapore, and the UK (England and Wales).

Table 3 shows projected trends in life expectancy and healthy life expectancy at birth for the 23 selected countries. Healthy life expectancy is a type of health-expectancy indicator that summarises the average

health in a population in terms of equivalent years of full health, accounting for the distribution of health states. We calculated healthy life expectancy from the projected death rates and projected rates for prevalence-based years of life lived with disability using methods described elsewhere.[37] Achievement of the global goal would result in additional gains in healthy life expectancy ranging from 2·1 years in Mexico to 0·7 years in South Africa (table 2). Gains in healthy life expectancy are similar in magnitude to gains in life expectancy, suggesting that the additional years of life gained through achievement of the global goal are essentially years of full health.

We estimate the long-term economic savings of achieving the global goal by comparing the GDP levels under a scenario in which the mortality reductions specified by the global goal are achieved with those that are projected according to the base mortality projections scenario. As little as a 2% yearly additional reduction in mortality rates from chronic diseases would save almost 10% of the expected loss in income and around $8 billion collectively for the 23 countries by 2015.

Our estimates were most sensitive to the assumptions for the rate at which output increases with every unit increase in capital inputs and the proportion of medical expenditures financed from savings. However, the results remained robust under different values for these assumptions, and their effect on the results decreased towards the end of the analysis period.

This analysis provides a very conservative estimate of the economic effect of chronic diseases since it focused only on coronary heart diseases, diabetes, and stroke, and excluded cancers, respiratory diseases, and other chronic diseases, many of which share common risk factors. Furthermore, the analysis was limited to the effect of chronic diseases on adult mortality and on savings

	Life expectancy at birth (years)				Healthy life expectancy at birth (years)			
	2005	Baseline scenario 2015	Global goal 2015	Gain (years)	2005	Baseline scenario 2015	Global goal 2015	Gain (years)
Mexico	74·3	75·0	77·0	2·0	64·8	66·1	68·2	2·1
Turkey	71·4	73·6	75·6	1·9	61·8	64·2	66·2	1·9
Brazil	69·6	71·6	73·4	1·8	60·3	62·5	64·4	1·9
Egypt	67·7	70·1	72·1	2·0	59·1	61·6	63·5	1·9
Iran	69·8	71·7	73·5	1·8	59·5	61·6	63·5	1·9
Colombia	72·2	72·2	73·9	1·7	61·9	62·4	64·3	1·8
Bangladesh	63·9	66·9	68·6	1·7	55·4	58·4	60·2	1·8
Poland	74·7	75·3	77·2	1·9	65·6	66·4	68·1	1·8
Philippines	69·4	71·7	73·5	1·7	59·7	62·0	63·8	1·8
Indonesia	67·6	70·2	72·0	1·7	58·3	61·1	62·9	1·7
Ukraine	67·1	68·1	70·0	1·9	59·5	60·6	62·3	1·7
China	72·1	74·0	75·7	1·7	65·1	67·2	68·9	1·7
Russia	64·6	65·9	67·8	1·8	56·9	58·3	59·9	1·7
India	62·5	65·4	67·1	1·7	54·4	57·3	59·0	1·6
Argentina	74·7	75·5	77·3	1·8	65·6	66·7	68·2	1·6
Thailand	70·7	73·6	75·4	1·8	60·9	64·0	65·5	1·6
Vietnam	69·9	70·9	72·6	1·7	61·7	62·8	64·3	1·5
Pakistan	62·5	65·4	67·0	1·6	54·2	57·1	58·6	1·5
Burma	60·9	65·4	67·0	1·6	53·4	57·9	59·4	1·4
Ethiopia	50·0	52·4	53·4	1·1	42·8	45·2	46·3	1·1
Nigeria	48·7	50·3	51·3	1·0	41·5	43·1	44·2	1·1
Democratic Republic of the Congo	45·7	47·7	48·5	0·9	39·0	40·9	41·7	0·8
South Africa	48·4	49·0	49·7	0·7	42·6	43·3	44·0	0·7

Countries are listed in descending order of healthy life expectancy gain.

Table 3: **Projected life expectancy at birth and healthy life expectancy at birth for 23 selected countries in 2005 and 2015 under the baseline and global goal projection scenarios**

primarily because of expenditures on long-term medical care. It does not take into account other adverse effects of illness on individuals' savings and investment, including reduced investment in child education.

Our economic estimates are also substantially lower than are those using the full income approach, which was reported by WHO in its 2005 report on chronic diseases.[1] This finding is not surprising, since those calculations valued every life lost at 100 times GDP and added this amount to the estimated lost production, which are the numbers reported in this paper. The notions are quite different, and we err on the side of caution by reporting here only the losses of economic output rather than some notional welfare value of lost life.

Conclusions

Our results show that population growth and ageing will drive a substantial increase in the numbers of deaths from chronic disease globally, and particularly in low-income and middle-income countries, where we project an 18% increase between 2006 and 2015. These deaths occur at younger ages than chronic disease deaths in high-income countries. Two major factors account for the grim forecasts on the economic effect of chronic diseases: the lost labour units because of deaths from chronic disease and the costs of treating chronic disease, which continue to increase annually as noted in many wealthy countries such as the USA and Japan.[38–42]

However, the rising burden of chronic disease will be especially severe in low-income and middle-income countries, which are those that can least afford a health-related setback to development. In these countries, resources for treatment are already stretched to the limit, and chronic disease prevention—focusing on reducing known, modifiable risk factors—will therefore be central to incidence and mortality reductions.

The effect of chronic diseases on health and on economic welfare is clearly substantial. A lot could be done at fairly low cost to prevent and control these epidemics, as shown in later papers in this Series. The question is to what extent should governments get involved, or can prevention and control be left to people's personal decisions? To public-health professionals, the answer is obvious, but for economists and many of the governments who must invest in this area it is unclear. Many economists and governments give far greater attention to communicable diseases than to chronic disease, even when their burden is no longer as high as it is for chronic diseases. This finding is partly because economists argue that free choices of individuals and firms, expressed in free markets, result in the production and the consumption of the goods that people value most highly. Published work has shown why these free-market interactions do not result in optimum outcomes in health, which provides the rationale for the government involvement in the sector.[43] However, these arguments are often thought to apply more to communicable than to chronic diseases.

Most of the arguments for government involvement in the health sector apply equally as well to chronic diseases. First, free markets work only if individual purchasers have sufficient information to ask for the services that will provide them with their desired outcomes. This approach does not apply to most treatment decisions for chronic and communicable diseases, since patients simply do not have enough knowledge to negotiate with health professionals about the appropriate treatment. The scarcity of information also applies to prevention. For example, a US study showed that, although consumers knew that smoking is harmful to health, they had little exposure to information about the comparative harmful effects of various cigarette brands.[44] Another study concluded that higher smoking levels in Europe than in the USA are largely because of little information about the health consequences from smoking.[45] Therefore, individuals cannot make informed choices about prevention and treatment without external assistance. Governments have an important role in stimulating the generation of information, and making this information available and widely understood.

Second, some types of information provision and dissemination can also be regarded as having public-good characteristics, since all people can benefit from its production without reducing the ability of other people to also benefit. Furthermore, with this approach it is difficult to exclude people from benefiting once the good is produced. This combination of characteristics means that the product is unlikely to be produced without collective action because production is not profitable for individuals or companies. Because people cannot easily be excluded from obtaining many types of knowledge, especially relating to prevention and promotion, the private sector has little incentive to produce and disseminate it, and governments must step in. Again, this argument should not apply more to communicable than to chronic diseases.

Third, the addictive nature of some of the behaviours contributing to chronic diseases—eg, smoking and alcohol consumption—prevents people acting in their own best interests even when they have the best available information. This argument is, in fact, more relevant to chronic than to communicable diseases.

Fourth, the actions of individuals (so-called externalities) sometimes affect the health of others. Undoubtedly, externalities are substantial for some types of communicable diseases. Unsafe sexual behaviour not only has risks for the individual but also for the partner. However, there are still many externalities connected with some behaviours relating to chronic diseases. For example, smokers not only harm their own health but also the health of others who inhale the fumes. Heavy alcohol use is associated not just with reduced health for the user, but also in violence and health costs to third parties. Individuals generally take into account only the costs and benefits to themselves of their own actions, ignoring the harmful effects of their behaviour on others. These externalities need government involvement to redress the balance.

Finally, although markets can sometimes operate efficiently, they do so for any type of distribution of income; poor people might purchase goods and services that maximise their welfare for a given income, but they will purchase less than those who are rich. Whereas this argument is not necessarily regarded as inequitable for the purchase of cars, it is considered to be inequitable in many other areas, including health, which is another reason why governments have traditionally been heavily involved in the health sector, to ensure that everyone has access to at least a minimum set of health services, including preventive services. Although most communicable diseases are widely accepted as primarily diseases of poor people, policymakers do not fully understand that chronic diseases have also become diseases of poor people in most settings.[1] Moreover, people in low socioeconomic groups are unlikely to have enough financial savings if they contract chronic diseases, and are less likely to have insurance cover to pay for medical expenses than are those in high-income groups.

Therefore governments should take an active role in the prevention and treatment of chronic disease.[46]

How realistic is it to propose a global goal of an additional 2% reduction in chronic disease mortality rates per year over the next decade and to advocate for action by governments and international agencies to achieve that goal? Estimates have shown that over 70% of cardiovascular disease deaths, around 40% of chronic respiratory disease deaths, 34% of cancer deaths, and about 50% of all chronic disease deaths are attributable to a small number of known modifiable risk factors.[47,48] The following papers in this Series make the case that a small set of population-wide and individual interventions have the potential to achieve this global goal in the 23 selected countries.

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