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The Global Economic Burden of Non-communicable Diseases

A report by the World Economic Forum
and the Harvard School of Public Health

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See www.weforum.org/EconomicsOfNCD

See online appendix for detailed notes on the data sources and methods: www.weforum.org/EconomicsOfNCDappendix

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Preface

Non-communicable diseases have been established as a clear threat not only to human health, but also to development and economic growth. Claiming 63% of all deaths, these diseases are currently the world's main killer. Eighty percent of these deaths now occur in low- and middle-income countries. Half of those who die of chronic non-communicable diseases are in the prime of their productive years, and thus, the disability imposed and the lives lost are also endangering industry competitiveness across borders.

Recognizing that building a solid economic argument is ever more crucial in times of financial crisis, this report brings to the global debate fundamental evidence which had previously been missing: an account of the overall costs of NCDs, including what specific impact NCDs might have on economic growth.

The evidence gathered is compelling. Over the next 20 years, NCDs will cost more than US$ 30 trillion, representing 48% of global GDP in 2010, and pushing millions of people below the poverty line. Mental health conditions alone will account for the loss of an additional US$ 16.1 trillion over this time span, with dramatic impact on productivity and quality of life. By contrast, mounting evidence highlights how millions of deaths can be averted and economic losses reduced by billions of dollars if added focus is put on prevention. A recent World Health Organization report underlines that population-based measures for reducing tobacco and harmful alcohol use, as well as unhealthy diet and physical inactivity, are estimated to cost US$ 2 billion per year for all low- and middle-income countries, which in fact translates to less than US$ 0.40 per person.

The rise in the prevalence and significance of NCDs is the result of complex interaction between health, economic growth and development, and it is strongly associated with universal trends such as ageing of the global population, rapid unplanned urbanization and the globalization of unhealthy lifestyles. In addition to the tremendous demands that these diseases place on social welfare and health systems, they also cause decreased productivity in the workplace, prolonged disability and diminished resources within families.

The results are unequivocal: a unified front is needed to turn the tide on NCDs. Governments, but also civil society and the private sector must commit to the highest level of engagement in combatting these diseases and their rising economic burden. Global business leaders are acutely aware of the problems posed by NCDs. A survey of business executives from around the world, conducted by the World Economic Forum since 2009, identified NCDs as one of the leading threats to global economic growth. Therefore, it is also important for the private sector to have a strategic vision on how to fulfill its role as a key agent for change and how to facilitate the adoption of healthier lifestyles not only by consumers, but also by employees. The need to create a global vision and a common understanding of the action required by all sectors and stakeholders in society has reached top priority on the global agenda this year, with the United Nations General Assembly convening a High-Level Meeting on the prevention and control of NCDs.

If the challenges imposed on countries, communities and individuals by NCDs are to be met effectively this decade, they need to be addressed by a strong multistakeholder and cross-sectoral response, meaningful changes and adequate resources. We are pleased and proud to present this report, which we believe will strengthen the economic case for action.

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Executive Summary

As policy-makers search for ways to reduce poverty and income inequality, and to achieve sustainable income growth, they are being encouraged to focus on an emerging challenge to health, well-being and development: non-communicable diseases (NCDs).

After all, 63% of all deaths worldwide currently stem from NCDs – chiefly cardiovascular diseases, cancers, chronic respiratory diseases and diabetes. These deaths are distributed widely among the world's population – from high-income to low-income countries and from young to old (about one-quarter of all NCD deaths occur below the age of 60, amounting to approximately 9 million deaths per year). NCDs have a large impact, undercutting productivity and boosting healthcare outlays. Moreover, the number of people affected by NCDs is expected to rise substantially in the coming decades, reflecting an ageing and increasing global population.

With this in mind, the United Nations is holding its first High-Level Meeting on NCDs on 19-20 September 2011 – this is only the second time that a high-level UN meeting is being dedicated to a health topic (the first time being on HIV/AIDS in 2001). Over the years, much work has been done estimating the *human* toll of NCDs, but work on estimating the *economic* toll is far less advanced.

In this report, the World Economic Forum and the Harvard School of Public Health try to inform and stimulate further debate by developing new estimates of the global economic burden of NCDs in 2010, and projecting the size of the burden through 2030. Three distinct approaches are used to compute the economic burden: (1) the standard cost of illness method; (2) macroeconomic simulation and (3) the value of a statistical life. This report includes not only the four major NCDs (the focus of the UN meeting), but also mental illness, which is a major contributor to the burden of disease worldwide. This evaluation takes place in the context of enormous global health spending, serious concerns about already strained public finances and worries about lacklustre economic growth. The report also tries to capture the thinking of the business community about the impact of NCDs on their enterprises.

Five key messages emerge:

- First, NCDs already pose a substantial economic burden and this burden will evolve into a staggering one over the next two decades. For example, with respect to cardiovascular disease, chronic respiratory disease, cancer, diabetes and mental health, the macroeconomic simulations suggest a cumulative output loss of US$ 47 trillion over the next two decades. This loss represents 75% of global GDP in 2010 (US$ 63 trillion). It also represents enough money to eradicate two dollar-a-day poverty among the 2.5 billion people in that state for more than half a century.

- Second, although high-income countries currently bear the biggest economic burden of NCDs, the developing world, especially middle-income countries, is expected to assume an ever larger share as their economies and populations grow.

- Third, cardiovascular disease and mental health conditions are the dominant contributors to the global economic burden of NCDs.

- Fourth, NCDs are front and centre on business leaders' radar. The World Economic Forum's annual Executive Opinion Survey (EOS), which feeds into its Global Competitiveness Report, shows that about half of all business leaders surveyed worry that at least one NCD will hurt their company's bottom line in the next five years, with similarly high levels of concern in low-, middle- and high-income countries – especially in countries where the quality of healthcare or access to healthcare is perceived to be poor. These NCD-driven concerns are markedly higher than those reported for the communicable diseases of HIV/AIDS, malaria and tuberculosis.

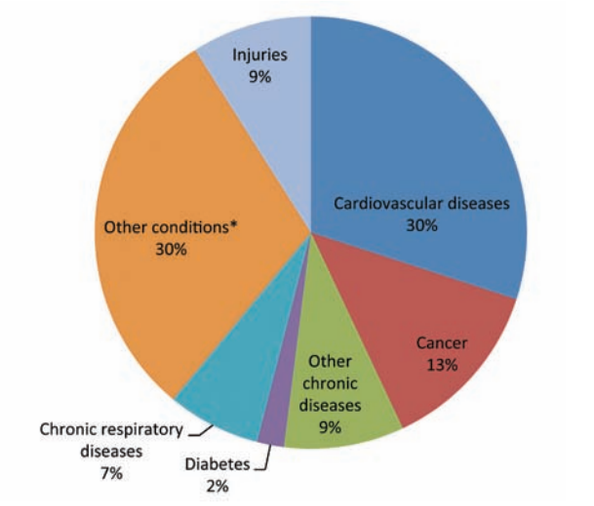
- Fifth, the good news is that there appear to be numerous options available to prevent and control NCDs. For example, the WHO has identified a set of interventions they call "Best Buys". There is also considerable scope for the design and implementation of programmes aimed at behaviour change among youth and adolescents, and more cost-effective models of care – models that reduce the care-taking burden that falls on untrained family members. Further research on the benefits of such interventions in relation to their costs is much needed.

It is our hope that this report informs the resource allocation decisions of the world's economic leaders – top government officials, including finance ministers and their economic advisors – who control large amounts of spending at the national level and have the power to react to the formidable economic threat posed by NCDs.

1. Background on NCDs

Non-communicable diseases (NCDs) impose a large burden on human health worldwide. Currently, more than 60% of all deaths worldwide stem from NCDs (Figure 1). Moreover, what were once considered "diseases of affluence" have now encroached on developing countries. In 2008, roughly four out of five NCD deaths occurred in low- and middle-income countries (WHO, 2011a), up sharply from just under 40% in 1990 (Murray & Lopez, 1997). Moreover, NCDs are having an effect throughout the age distribution – already, one-quarter of all NCD-related deaths are among people below the age of 60 (WHO, 2011a). NCDs also account for 48% of the healthy life years lost (Disability Adjusted Life Years–DALYs)[1] worldwide (versus 40% for communicable diseases, maternal and perinatal conditions and nutritional deficiencies, and 1% for injuries) (WHO, 2005a).

Figure 1: NCDs constitute more than 60% of deaths worldwide

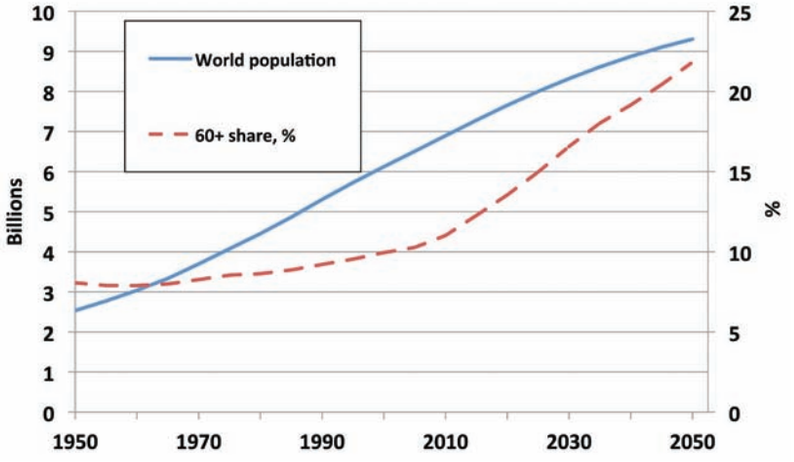


* "Other conditions" comprises communicable diseases, maternal and perinatal conditions and nutritional deficiencies.

Data are for 2005. Source: (WHO, 2005a)

Adding urgency to the NCD debate is the likelihood that the number of people affected by NCDs will rise substantially in the coming decades. One reason is the interaction between two major demographic trends. World population is increasing, and although the rate of increase has slowed, UN projections indicate that there will be approximately 2 billion more people by 2050. In addition, the share of those aged 60 and older has begun to increase and is expected to grow very rapidly in the coming years (see Figure 2). Since NCDs disproportionately affect this age group, the incidence of these diseases can be expected to accelerate in the future. Increasing prevalence of the key risk factors will also contribute to the urgency, particularly as globalization and urbanization take greater hold in the developing world.

Figure 2: The world population is growing and getting older



Source: (United Nations Population Division, 2011)

[1] The World Health Organization defines DALYs (Disability Adjusted Life Years) as "The sum of years of potential life lost due to premature mortality and the years of productive life lost due to disability."(World Health Organization, 2011b) A DALY is a healthy life year lost.

In light of the seriousness of these diseases, both in human and financial terms, the United Nations is holding its first High-Level Meeting on NCDs on 19-20 September 2011. This is only the second time that the UN General Assembly is dedicating a high-level meeting to a health issue (the first time being on HIV/AIDS in 2001). Meanwhile, countries are developing strategies and guidelines for addressing NCDs and risk factors through innovative changes to health infrastructure, new funding mechanisms, improved surveillance methods and policy responses (WHO, 2011a). Yet the reality is that these approaches as they stand today are severely inadequate.

Defining NCDs

What exactly are NCDs?[2,3] They are defined as diseases of long duration, generally slow progression and they are the major cause of adult mortality and morbidity worldwide (WHO, 2005a). Four main diseases are generally considered to be dominant in NCD mortality and morbidity: cardiovascular diseases (including heart disease and stroke), diabetes, cancer and chronic respiratory diseases (including chronic obstructive pulmonary disease and asthma) (see Box 1).

The High-Level Meeting will focus on the four main diseases, but it is important to bear in mind that they do not make up a comprehensive list. A key set of diseases not included on the list are mental illnesses – including unipolar depressive disorder, alcohol use disorders and schizophrenia, all major contributors to the economic losses stemming from NCDs. Also excluded are sense disorders such as glaucoma and hearing loss, digestive diseases such as cirrhosis, and musculoskeletal diseases such as rheumatoid arthritis and gout. These conditions impose private and social costs that are also likely to be substantial. For example, musculoskeletal diseases can severely diminish one's capacity to undertake manual labour, such as farming, which is the dominant productive activity in rural settings that are home to 50% of the world's population.

Moreover, the term NCD is something of a misnomer because it encompasses some diseases that are infectious in origin. Human papillomavirus is a cause of various cancers (for example, cervical, anal, genital and oral) and a portion of gastric cancers are caused by the *H. pylori* bacteria. Indeed, up to one in five cancers is said to be caused by infection. In the social sphere, NCD risks are also shared – eating, drinking and smoking habits are powerfully influenced by social networks.

Box 1: A snapshot of the five major NCDs

Cardiovascular disease (CVD) refers to a group of diseases involving the heart, blood vessels, or the sequelae of poor blood supply due to a diseased vascular supply. Over 82% of the mortality burden is caused by ischaemic or coronary heart disease (IHD), stroke (both hemorrhagic and ischaemic), hypertensive heart disease or congestive heart failure (CHF). Over the past decade, CVD has become the single largest cause of death worldwide, representing nearly 30% of all deaths and about 50% of NCD deaths (WHO, 2011a). In 2008, CVD caused an estimated 17 million deaths and led to 151 million DALYs (representing 10% of all DALYs in that year). Behavioural risk factors such as physical inactivity, tobacco use and unhealthy diet explain nearly 80% of the CVD burden (Gaziano, Bitton, Anand, Abrahams-Gessel & Murphy, 2010).

Cancer refers to the rapid growth and division of abnormal cells in a part of the body. These cells outlive normal cells and have the ability to metastasize, or invade parts of the body and spread to other organs. There are more than 100 types of cancers, and different risk factors contribute to the development of cancers in different sites. Cancer is the second largest cause of death worldwide, representing about 13% of all deaths (7.6 million deaths). Recent literature estimated the number of new cancer cases in 2009 alone at 12.9 million, and this number is projected to rise to nearly 17 million by 2020. (Beaulieu, Bloom, Reddy Bloom, & Stein, 2009).

Chronic respiratory diseases refer to chronic diseases of the airways and other structures of the lung. Some of the most common are asthma, chronic obstructive pulmonary disease (COPD), respiratory allergies, occupational lung diseases and pulmonary hypertension, which together account for 7% of all deaths worldwide (4.2 million deaths). COPD refers to a group of progressive lung diseases that make it difficult to breathe – including chronic bronchitis and emphysema (assessed by pulmonary function and x-ray evidence). Affecting more than 210 million people worldwide, COPD accounts for 3-8% of total deaths in high-income countries and 4-9% of total deaths in low- and middle-income countries (LMICs) (Mannino et al., 2007).

[2] The World Health Organization (WHO) refers to these conditions as "chronic diseases." For more information, see (WHO, 2005a)

[3] Non-communicable diseases are identified by WHO as "Group II Diseases," a category that aggregates (based on ICD-10 code) the following conditions/causes of death: Malignant neoplasms, other neoplasms, diabetes mellitus, endocrine disorders, neuropsychiatric conditions, sense organ diseases, cardiovascular diseases, respiratory diseases (e.g. COPD, asthma, other), digestive diseases, genitourinary diseases, skin diseases, musculoskeletal diseases (e.g. rheumatoid arthritis), congenital anomalies (e.g. cleft palate, down syndrome), and oral conditions (e.g. dental caries). These are distinguished from Group I diseases (communicable, maternal, perinatal and nutritional conditions) and Group III diseases (unintentional and intentional injuries).

Diabetes is a metabolic disorder in which the body is unable to appropriately regulate the level of sugar, specifically glucose, in the blood, either by poor sensitivity to the protein insulin, or due to inadequate production of insulin by the pancreas. Type 2 diabetes accounts for 90-95% of all diabetes cases. Diabetes itself is not a high-mortality condition (1.3 million deaths globally), but it is a major risk factor for other causes of death and has a high attributable burden of disability. Diabetes is also a major risk factor for cardiovascular disease, kidney disease and blindness.

Mental illness is a term that refers to a set of medical conditions that affect a person's thinking, feeling, mood, ability to relate to others and daily functioning. Sometimes referred to as mental disorders, mental health conditions or neuropsychiatric disorders, these conditions affect hundreds of millions of people worldwide. In 2002, 154 million people suffered from depression globally, 25 million people from schizophrenia and over 100 million people suffered from alcohol or drug abuse disorders (WHO, 2011a). Close to 900,000 people die from suicide each year. Neuropsychiatric conditions are also a substantial contributor to DALYs, contributing 13% of all DALYs in 2004 (WHO, 2005b).

Major NCD risk factors

NCDs stem from a combination of modifiable and non-modifiable risk factors.

Non-modifiable risk factors refer to characteristics that cannot be changed by an individual (or the environment) and include age, sex, and genetic make-up. Although they cannot be the primary targets of interventions, they remain important factors since they affect and partly determine the effectiveness of many prevention and treatment approaches. A country's age structure may convey important information on the most prevalent diseases, as may the population's racial/ethnic distribution.

Modifiable risk factors refer to characteristics that societies or individuals can change to improve health outcomes. WHO typically refers to four major ones for NCDs: poor diet, physical inactivity, tobacco use, and harmful alcohol use (WHO, 2011a).

Poor diet and physical inactivity. The composition of human diets has changed considerably over time, with globalization and urbanization making processed foods high in refined starch, sugar, salt and unhealthy fats cheaply and readily available and enticing to consumers – often more so than natural foods (Hawkes, 2006; Kennedy, Nantel, & Shetty, 2004; Lieberman, 2003; WHO, 2002). As a result, overweight and obesity, and associated health problems, are on the rise in the developing world (Cecchini, et al., 2010). Exacerbating matters has been a shift toward more sedentary lifestyles, which has accompanied economic growth, the shift from agricultural economies to service-based economies, and urbanization in the developing world. This spreading of the fast food culture, sedentary lifestyle and increase in bodyweight has led some to coin the emerging threat a "globesity" epidemic (Bifulco & Caruso, 2007; Deitel, 2002; Schwartz, 2005).

Tobacco. High rates of tobacco use are projected to lead to a doubling of the number of tobacco-related deaths between 2010 and 2030 in low- and middle-income countries. Unless stronger action is taken now, the 3.4 million tobacco-related deaths today will become 6.8 million in 2030 (NCD Alliance, 2011). A 2004 study by the Food and Agriculture Organization (FAO) predicted that developing countries would consume 71% of the world's tobacco in 2010 (FAO, 2004). China is a global tobacco hotspot, with more than 320 million smokers and approximately 35% of the world's tobacco production (FAO, 2004; *Global Adult Tobacco Survey - China Section*, 2010). Tobacco accounts for 30% of cancers globally, and the annual economic burden of tobacco-related illnesses exceeds total annual health expenditures in low- and middle-income countries (American Cancer Society & World Lung Foundation, 2009).

Alcohol. Alcohol use has been causally linked to many cancers and in excessive quantity with many types of cardiovascular disease (Boffetta & Hashibe, 2006; Ronksley, Brien, Turner, Mukamal, & Ghali, 2011). Alcohol accounted for 3.8% of deaths and 4.6% of DALYs in 2004 (GAPA, 2011). Evidence also shows a causal, dose-response relationship between alcohol use and several cancer sites, including the oral cavity, pharynx, larynx, oesophagus, liver and female breast (Rehm, et al., 2010).[4]

[4] Although low to moderate alcohol use (less than 20g per day) has been linked to some advantageous cardiovascular outcomes (particularly ischaemic heart disease and strokes), heavy chronic drinking has been linked to adverse cardiovascular outcomes. The detrimental effects of heavy drinking have been shown to outweigh its benefits by two- to three-fold based on cost-benefit calculations of lives saved or improved versus lives lost or disabled (Parry & Rehm, 2011).

The pathway from modifiable risk factors to NCDs often operates through what are known as “intermediate risk factors” – which include overweight/obesity, elevated blood glucose, high blood pressure and high cholesterol. Secondary prevention measures can tackle most of these risk factors, such as changes in diet or physical activity or the use of medicines to control blood pressure and cholesterol, oral agents or insulin to control blood sugar and pharmacological/surgical means to control obesity.

Although intervening on intermediate risk factors may be more effective (and more cost-effective) than waiting until NCDs have fully developed, treating intermediate risk factors may, in turn, be less effective (and less cost-effective) than primary prevention measures or creating favorable social and policy environments to reduce vulnerability to developing disease (Brownell & Frieden, 2009; National Commission on Prevention Priorities, 2007; Satcher, 2006; Woolf, 2009). After all, even those with the will to engage in healthy practices may find it difficult to do so because they live or work in environments that restrict their ability to make healthy choices. For these reasons, the need to address social determinants of NCDs was reiterated at the 64th World Health Assembly held in Geneva, Switzerland in May 2011 by WHO Member States in preparation for the UN High-Level Meeting in September 2011.

Macro-level contextual factors include the built and social environment; political, economic and legal systems; the policy environment; culture; and education. Social determinants are often influenced by political systems, whose operation leads to important decisions about the resources dedicated to health in a given country. For example, in the United States, free-market systems often promote an individualistic cultural and social environment – which affects the amount of resources allocated for healthcare, how these resources are spent and the balance of state versus out-of-pocket expenditures that are committed to protect against, and cope with, the impact of disease (Kaiser, 2010; Siddiqi, Zuberi, & Nguyen, 2009). Political systems that promote strong social safety nets tend to have fewer social inequalities in health (Beckfield & Krieger, 2009; Navarro & Shi, 2001).

Social structure is also inextricably linked with economic wealth, with the poor relying more heavily on social support through non-financial exchanges with neighbours, family and friends to protect against, and cope with, the impact of disease. Wilkinson and Marmot have written extensively on the role that practical, financial and emotional support plays in buoying individuals in times of crisis, and the positive impact this can have on multiple health outcomes including chronic disease (Wilkinson & Marmot, 2003).

The United Nations Population Fund (UNFPA) reports that the proportion of the world’s population living in urban areas surpassed half in 2008. The United Nations Human Settlements Programme (UN-HABITAT) estimates that by 2050, two-thirds of people around the world will live in urban areas. Approximately 1 billion people live in urban slums. According to the UN, 6.5% of cities are made up of slums in the developed world, while in the developing world the figure is over 78%. Although most studies note an economic “urban advantage” for those living in cities because of greater access to services and jobs, this advantage is often diminished by the higher cost of living in cities and low quality of living conditions in urban slums (ECOSOC, 2010).

In addition, urbanization and globalization heavily influence resource distribution within societies, often exacerbating geographic and socioeconomic inequalities in health (Hope, 1989; Schuftan, 1999). Notably, a 100-country study by Ezzati et al. found that both body mass index (BMI) and cholesterol levels were positively associated with a rise in urbanization and national income (Ezzati, et al., 2005). At a regional level, a study conducted by Allender et al. similarly found strong links between the proportion of people living in urban areas and NCD risk factors in the state of Tamil Nadu, India (Allender, et al., 2010). This study observed a positive association between urbanicity and smoking, BMI, blood pressure and low physical activity among men. Among women, urban concentration was positively associated with BMI and low physical activity. Similar findings have been observed in other countries as well (Vlahov & Galea, 2002). A growing literature has emerged on the effect of the built environment and global trends toward urbanization on health (Michael, et al., 2009).

Education matters, too. This effect is at least partially attributable to the better health literacy that results from each additional year of formal education. Improved health literacy has been linked to improved outcomes in breastfeeding, reduction in smoking and improved diets and lowered cholesterol levels (ECOSOC, 2010).

Income also matters. The evidence indicates a dynamic relationship between socioeconomic status (SES) and health, mediated by a country's income level (Braveman et al., 2005). In less developed countries, there tends to be a positive association between SES and obesity. But as a country's GDP increases, this association changes to a negative one (McLaren, 2007). In other words, in poorer countries, higher SES groups tend to be at greater risk of developing obesity-related NCDs, whereas in wealthier countries, lower SES groups tend to be a greater risk (Monteiro, Moura, Conde, & Popkin, 2004). Thus, it is important to develop country-specific programmes to address these varied dynamics and to ensure that strategies are integrated into other country-level social policies to meet health and development goals.

Further, distinguishing the risk of developing disease from the risk of disease mortality will be critical when making policy decisions regarding the costs and benefits of particular interventions. While the wealthy may be more likely to acquire NCDs in low- and middle-income countries, the poor are much more likely to die from them because they lack the resources to manage living with disease. NCDs are also more likely to go undetected in poor populations, resulting in even greater morbidity, diminished quality of life and lost productivity. At a population level, this dynamic can result in a disease-poverty trap, in which overall workforce quantity and quality is compromised owing to individuals being pushed out by the burden of disease. This can diminish a country's economic output and hinder its pace of economic growth.

Anticipated global economic impact

Although research on the global economic effects of non-communicable diseases is still in a nascent stage, economists are increasingly expressing concern that NCDs will result in long-term macroeconomic impacts on labour supply, capital accumulation and GDP worldwide with the consequences most severe in developing countries (Abegunde & Stanciole, 2006; Abegunde et al., 2007; Mayer-Foulkes, 2011; Nikolic, Stanciole, & Zaydman, 2011; Suhrcke, Nugent, Stuckler, & Rocco, 2006).[5]

Globally, the labour units lost owing to NCD deaths and the direct medical costs of treating NCDs have reduced the quality and quantity of the labour force and human capital (Mayer-Foulkes, 2011). In the United States, men with chronic disease worked 6.1% fewer hours and women worked 3.9% fewer hours (Suhrcke, Stuckler, & Rocco, 2006). Pronk et al. found that a "healthy" lifestyle in the US working-age population reduced healthcare costs by 49% in adults aged 40 and above (Mayer-Foulkes, 2011). In 2002, Sturm found that obesity increased individual annual healthcare costs by 36%, smoking by 21% and heavy drinking by 10% (Mayer-Foulkes, 2011).

In terms of a single NCD, available evidence indicates that the estimated cost of new cancer cases in 2009 was US$ 286 billion globally (Beaulieu, Bloom, Reddy Bloom, & Stein, 2009). This estimate is based on the cost-of-illness approach and includes treatment and care costs, research and development costs associated with cancer control, and foregone income due to the inability to work. But this estimate is conservative, as it does not include the cost of cancer screening and prevention, lost income due to cancer mortality or future treatment costs. A recent study conducted by the American Cancer Society estimated the cost of DALYs due to cancer worldwide in 2008 at US$ 895 billion (John & Ross, 2010). In contrast to the previous study cited here, this estimate represents global prevalence in 2008 (rather than global incidence in 2009). In addition, it does not include direct medical costs, suggesting that it provides a lower-bound estimate of the true economic burden.

For the developing world, a US Institute of Medicine (IOM) report on the macroeconomic impacts of cardiovascular disease and chronic diseases in a number of countries (Fuster & Kelly, 2010) suggests that the economic impact of CVD and related chronic diseases (such as diabetes and COPD) is large. Estimates ranged from an annual US$ 3 billion for direct medical costs of obesity-related diabetes, coronary heart disease, hypertension and stroke in China to US$ 72 billion for treatment of and productivity losses due to five chronic conditions in Brazil.

NCDs also compromise future economic and human development because poverty and ill-health are often passed down from one generation to the next. For example, poor nutrition may not only lead to diabetes-related morbidity but it may also impair *in utero* growth and compromise fetal development. The developmental origins hypothesis ("Barker Hypothesis") suggests that fetal growth adaptations occur relative to biological conditions *in utero* and that the mother's physiological condition may influence the health trajectory of the newborn, potentially predisposing the child to adult diseases such as coronary heart disease, stroke, hypertension and diabetes later in life (De Boo & Harding, 2006; Paneth & Susser, 1995). Taking an approach to the issue of poverty and NCDs that acknowledges the connections between social and health conditions over the lifespan is, therefore, likely to be useful in addressing the root causes and consequences of these diseases in the long term.

[5] For a detailed explanation of the pathways through which NCDs burden low- and middle-income countries, see Nikolic et al., 2011.

At the microeconomic level of households, studies suggest relatively sizable impacts. In Jamaica, 59% of those affected with chronic disease experienced financial difficulties and in many cases avoided medical treatment as a result (Henry-Lee & Yearwood, 1999). In Burkina Faso, the probability of catastrophic financial consequences more than doubled in households affected by chronic illness (Su, Kouyate, & Flessa, 2006). Other studies have shown that in Europe, chronic disease, particularly that of a husband, increased the probability of early retirement (Suhrcke, 2006). In Russia, chronic disease resulted in 5.6% lower median per-person income (Mayer-Foulkes, 2011).

Business awareness of NCDs

For the business community, an awareness of NCDs stems from a natural interest in the health of its workforce and that of the communities to which it markets its output. Worries focus on the impact of NCDs on workforce productivity via absenteeism, presenteeism (that is, a worker being present, but unable to effectively do the work), the loss of critical skills, and the need to promote employees prematurely when more experienced employees die or can no longer work. The business community is also concerned about the rising costs of health and life insurance and about the impact of NCDs on the size and purchasing power of its customer base. In response to these concerns, businesses can lessen the impact on the bottom line through workplace programmes aimed at prevention, early detection, treatment, and care.[6]

The 2010 Executive Opinion Survey, base of input for the World Economic Forum Competitiveness Report, revealed that NCDs figure prominently on the radar screen of the world's business leaders:

- Over one-half expect that NCDs, taken together, will have a serious, somewhat serious, or moderate impact on their company, and nearly one-third expect the impact to be more than moderate.
- The largest concerns caused by NCDs, both overall and within country income groups, are with cardiovascular disease and cancer.
- For high- and middle-income countries (but not low-income), concerns about NCDs exceed those about HIV/AIDS, malaria and tuberculosis.
- NCD concerns are greatest among business leaders in low-income countries, countries with poor quality healthcare and countries that offer poor access to healthcare. These concerns are lowest in high-income countries.
- Among regions, South Asia displays the highest level of concern that NCDs would have at least a somewhat serious impact on their business (nearly two-thirds of respondents).
- On a sectoral basis, business leaders in agriculture are the most concerned. Those in the health sector are more concerned than executives in food and beverage products, pharmaceuticals and biotechnology or financial services.

Regarding business policies and programmes to address NCDs and key risk factors, the answer was that many companies have adopted policies or initiated programmes to combat NCDs. These commitments vary by NCD and income level, as Table 1 shows, with high-income countries having a higher share of companies adopting them than low-income countries. On a regional basis, two-thirds of companies in Latin America and the Caribbean have taken anti-smoking initiatives, nearly two-thirds in the Middle East and North Africa have acted against alcohol, and East Asia and the Pacific lead the way with programmes focused on exercise, stress reduction and physical health.

Table 1: Companies favour tackling smoking and alcohol: Percentage of companies that have established and implemented policies and programmes to combat NCDs

Policy or programme	All countries	Low-income countries	High-income countries
Anti-smoking	59	37	74
Anti-alcohol	56	42	61
Incentives for exercise	30	21	35
Stress reduction	23	14	32
Physical health	36	23	42

[6] The Workplace Wellness Alliance. Delivering on Health and Productivity. (2011). World Economic Forum.

Box 2: World Economic Forum's Executive Opinion Survey 2010

The World Economic Forum's annual Executive Opinion Survey (EOS) generates much of the data used to construct the Global Competitiveness Index. To gain insight into how the business community perceives NCDs, the World Economic Forum started to include questions on NCDs in the 2010 questionnaire. This marks the first time that global businesses were surveyed about NCDs in the context of competitiveness. The survey was conducted in the first four months of 2010 and generated responses from more than 13,000 business executives in 139 countries.

The survey asked two key questions regarding NCDs. First, it polled executives on how serious an impact they expected on their companies from heart disease and related cardiovascular problems, cancer, mental illness and diabetes in the next five years. The impacts included death, disability, medical and funeral expenses, productivity and absenteeism, recruitment and training expenses, and revenues. The survey also asked executives about the implementation of business policies and programmes to address NCDs and key risk factors– specifically, smoking, alcohol, exercise, stress reduction, and physical and mental health.

As all surveys, EOS has strengths and weaknesses. It is based on a large sample of business leaders across 142 countries and serves as a baseline for subsequent years, facilitating the tracking of trends. It allows for study of variation by country, region, country income group and demographics, business sector, firm size, elder share of population and other covariates (for example, perceived efficiency of public spending in a country and whether poor public health is viewed as one of the top five problematic factors for doing business in a country).

However, the sample cannot be considered as completely representative of the business community in the countries included (despite EOS efforts to have the sample match each country's sectoral structure). To offer such comprehensive view the survey would benefit from further including small business owners. In addition, refining the wording of questions, and the interpretation of the response categories, including non-response, would strengthen the results. As with many international surveys, issues of translation interact with cultural differences in the understanding of words in ways that complicate interpretation of results. In spite of being a survey, and thus measuring business opinions which might not necessarily reflect facts verifiable by other means, EOS offers a unique window into the views of a large number of business leaders around the world on the topic of health issues and particularly NCDs.

2. The Global Economic Burden of NCDs

So how great is the economic burden of NCDs? To shed more light on this question, our study implements three methods that economists have developed to calculate the economic burden of health problems:

2.1 The cost-of-illness (COI) approach. This is a commonly used method that sets out to capture the economic impact of disease. It views the cost of NCDs as the sum of several categories of direct and indirect costs. The categories typically considered in this approach are: personal medical care costs for diagnosis, procedures, drugs and inpatient and outpatient care; non-medical costs, such as the costs of transportation for treatment and care; non-personal costs like those associated with information, education, communication and research; and income losses. Pain and suffering are also sometimes included in this approach.

2.2 The value of lost output: the economic growth approach. This method estimates the projected impact of NCDs on aggregate economic output (GDP) by considering how these diseases deplete labour, capital and other factors to production levels in a country. The WHO's EPIC model simulates the macroeconomic consequences of NCDs by linking disease to economic growth. It does this by modeling the two main factors of production, labour and capital, as depending negatively on NCDs.

2.3 The value of statistical life (VSL) approach. This method reflects a population's willingness to pay to reduce the risk of disability or death associated with NCDs. By placing an economic value on the loss of health itself, this approach goes beyond the impact of NCDs on GDP alone.

Each of these methods views the economic burden from a different perspective (for example, private versus public, or individual versus social), focuses on different cost components, refers to different timeframes (for example, one-year costs versus cumulative costs over multiple years), relies on distinct underlying data and assumptions, and in some cases focuses on different sets of NCDs. Therefore, the results that emerge from these three methods are not directly comparable. Moreover, interpretation of the results is complicated by comorbidities – that is, situations in which an individual is subject to two or more coexisting medical conditions or disease processes (see Box 3). That said, regardless of the approach, this report's results paint a picture of an extremely high economic burden globally – one that will grow over time if steps are not taken urgently to end "business as usual."

In our study, we focus on the four major NCDs plus mental illness. The rationale for choosing these four is that they are the categories identified for consideration by the UN High-Level Meeting on NCDs. We also include mental illness because of its substantial contribution to the burden of disease worldwide.[7]

NCD cost estimates (for 2010) and projections (for 2030) are reported by the World Bank's country-income groups (low-income, lower-middle-income, upper-middle-income and high-income), lower- and middle-income countries taken together (LMICs), and for the world as a whole. For 2030 estimates, we relied on the 2011 World Bank country-income group categorization. It is likely that some countries will be classified differently in the year 2030, however this report does not predict any changes in classification. It is worth noting that we have tried to report our results consistently in 2010 US$. Caution must be taken when comparing our results to existing literature, as other reports may present results in different figures (for example, international dollars).

2.1 Approach 1: Cost-of-Illness (COI)

Box 3: Comorbidity among NCDs

Comorbidities refer to cases of two or more coexisting medical conditions or disease processes in one individual. Comorbid conditions can be independent of one another. They can also arise because of common risk factors or the presence of one disease increasing the likelihood of developing another. With regard to common risk factors, CVD and many cancers share similar modifiable risks, such as smoking, obesity, physical inactivity, and unhealthy diets.

Diabetes is perhaps the best example of one chronic disease leading to increased risk of other diseases. Type 2 diabetes is not typically fatal on its own, but often leads to complications such as cardiovascular disease, kidney failure and infections that are indeed fatal. Another example is depression, which is known to impact the risk of diabetes and diabetes outcomes and may also do so in CVD (Mezuk, Eaton, Albrecht, & Golden, 2008). The reasons for this may include severity of risk factors, poor treatment compliance and the cumulative effects of response to stress. In the other causal direction, diabetes and CVD may contribute to the development of dementia in the elderly, although the effect size is unclear.

[7] Note: there are several chronic conditions that this report will not include, but it is recognized that these conditions contribute to suffering, premature death and disability, and economic hardship across the globe. Some of these conditions include kidney disease, blindness, hearing impairment and degenerative conditions such as ALS (Amyotrophic lateral sclerosis, or Lou Gehrig's disease), multiple sclerosis or Parkinson's disease. The reason that these conditions are not included in the proposed analysis is that the estimates provided will be an input to the UN High-Level Meeting on NCDs; the focus of the High-Level Meeting is on the four main categories of disease listed above. Therefore, the researchers aim to align the estimates with the scope of the UN High-Level Meeting on NCDs, adding the additional burden of mental health given its prevalence as well as relationship to the management of chronic conditions.

Comorbidities are a non-trivial feature of the burden of disease among adults. For example, among the roughly 75% of Canadians aged 65 and over with at least one chronic condition, one in three report having three or more chronic conditions (almost always including hypertension). In addition, this comorbid group routinely takes an average of 6 prescription medications (twice as many as seniors with one chronic condition), and accounts for 40% of healthcare spending among those aged 65 and over (Statistics Canada, 2008).

In 1999, nearly half of all U.S. Medicare* beneficiaries had three or more chronic conditions (Anderson & Horvath, 2002). In 1998, 70% of all individuals with hypertension had at least one other chronic condition (Anderson & Horvath, 2004). More recently, results from the United States' National Health and Nutrition Examination Survey showed that 68% of people with diabetes in the United States also have hypertension. Comorbidity data for people in low- and middle-income countries are lacking, but there is no reason to think that comorbidities are much less prevalent in those settings than in high-income countries.

Comorbidities pose a challenge to measuring the economic burden of NCDs. The challenge is not the same for every method used to estimate the burden. For example, macro-models such as EPIC are driven by NCD-specific mortality rates. As such, the NCD-specific cost results they yield will be sensitive to the accuracy of the NCD-specific mortality rates. Therefore, if some portion of diabetes mortality is attributed to CVD mortality, the cost of diabetes will be understated, and the cost of CVD will be overstated. However, the biases will tend to be offsetting when adding the two together because each NCD death is attributed to no more than one cause. The same logic applies to VSL results, since they are driven by NCD-specific DALYs. The COI method is most vulnerable to double counting associated with comorbidities. This is because data on personal medical care costs rarely divide those costs by morbid condition. Under these circumstances, the total cost of treatment may be incorrectly assigned to each disease, resulting in overestimates for each disease and in the aggregate.

*Medicare is a programme of the US Government that provides health insurance to those aged 65 and older and to certain other groups.

For this report, we start with the cost-of-illness approach, as it is considered by many to be an intuitive way to measure the economic burden of ill health. The COI approach distinguishes between direct and indirect costs of different health conditions. Direct costs refer to visible costs associated with diagnosis, treatment, and care. Direct costs may include personal medical care costs or personal non-medical costs such as the cost of transport to a health provider. Indirect costs refer to the invisible costs associated with lost productivity and income owing to disability or death. The COI approach can also accommodate non-personal health costs (such as those associated with research and public health education campaigns). The cost of pain and suffering may also be considered in this approach, although it is rare to find COI studies that place a monetary value on pain and suffering, and the present study does not do so. For further discussion of the COI approach, see page 115 of World Health Organization, 2009.

Implementation of the COI approach typically varies by health condition because of differences in the nature of available data. The interpretation of the results varies in corresponding fashion. This report presents the methods and results for estimating the cost of illness in 2010 and 2030 of the following conditions: cancer, cardiovascular disease, chronic obstructive pulmonary disease, diabetes and mental illness. Due to the nature of data available on the prevalence and cost of these five categories of NCDs, the COI method was implemented in different ways for each disease (See Table 2). Therefore, cost-of-illness results presented for any one of the conditions are not directly comparable to the results presented for another. Estimates for each disease are intended to give readers an understanding of the magnitude of costs for each illness, but not necessarily how the costs of each of the disease categories rank against one another.

Table 2: How the COI method is applied to five different NCDs

			Cancer	CVD	COPD	Diabetes	Mental Illness
Timeframe	First year after diagnosis		✔				
	One year only			✔	✔	✔	✔
Unit of analysis	New cases of an illness in a year[8]		✔				
	All cases of an illness in a year[9]				✔	✔	✔
	Events of ill-health[10]			✔			
Direct costs	Personal medical care costs		✔	✔	✔	✔	✔
	Personal non-medical care costs		✔				✔
Indirect Costs	Lost income	Due to mortality		✔	✔	✔	✔
		Due to disability and care seeking	✔	✔	✔	✔	✔
		Other			✔		
	Non-personal costs				✔		

Cancer

Cancer is a term that refers to the rapid growth and division of abnormal cells in a part of the body (American Cancer Society, 2009). Risk factors include genetic causes, behavioural causes (such as tobacco or alcohol use, physical inactivity and dietary factors), infections, environmental and occupational carcinogens and radiation. Different risk factors contribute to the development of cancers in different sites. Smokeless tobacco is largely responsible for oral cancers, whereas bacteria play a role in the development of stomach cancer. Many risk factors contribute to multiple types of cancers; similarly, a particular type of cancer may be caused by several different risk factors.

Cancer is the second largest contributor to NCD deaths and causes a great deal of suffering worldwide. This report estimates the global economic burden of new cancer cases in 2010 and projects that burden for 2030. Specifically, this section presents estimates of the following:

- Incident cases of cancer for the years 2010 and 2030.
- One-year costs of incident cases of cancer for the years 2010 and 2030.

This section draws heavily on methods used in the 2009 study published by the Economist Intelligence Unit (Beaulieu et al., 2009) (see Box 4). Results are presented for the world as a whole and are also broken down by World Bank income group.

[8] Also known as incident cases.
[9] Also known as prevalent cases.
[10] This is not the number of people with a condition, but rather the number of events of ill-health. Therefore, a person may be counted more than once if s/he experiences more than one event in a given year.

Box 4: Cancer model

The first step of the analysis involved estimating the number of new cases of cancer in the years 2010 and 2030. Incidence data were obtained from the International Agency for Research on Cancer's GLOBOCAN 2008 database, which gives incidence by sex and age group for 27 specific cancer sites and 184 countries and territories around the world (Ferlay et al., 2011). Incidence was assumed to be constant over time and was multiplied by population in 2010 and 2030 (United Nations Population Division, 2011) to calculate the number of new cancer cases expected in both years. This is known as a "business-as-usual" scenario, in which population is the only factor allowed to vary over time.

Costs were estimated in three distinct categories: medical costs, non-medical costs and income losses. Medical costs include the cost of medical procedures and services associated with treatment and care of cancer, including hospitalization, outpatient visits and prescription drugs. Non-medical costs include the costs of transportation for treatment and care, costs of complementary and alternative treatments for cancer and care-giving costs. Cost figures were based on a study of site-specific cancer costs in the Republic of Korea in 2002 and adjusted for cross-country differences in the cost of medical care per capita and to account for inflation (Kim, et al., 2008).

Income losses refer to output lost or foregone by cancer patients because of treatment or disability. Estimates of income loss per case were derived from the authors' calculations and based on data from both the aforementioned Korean study and an additional study (Yabroff, Bradley, Mariotto, Brown, & Feuer, 2008) that provided self-reported estimates of lost work days by cancer site. These figures were adjusted to account for inflation, higher costs in the first year after diagnosis and differences in income per capita across countries. The adjusted estimate of income loss per case was then multiplied by the estimated number of cases occurring among 15-64 year olds in 2010 and 2030, adjusting for real income growth.

See the online appendix for detailed notes on the data sources and methods:
www.weforum.org/EconomicsOfNCDappendix

What are the results?

As for incident cases, our study shows that there were an estimated 13.3 million new cases of cancer in 2010, with the number projected to rise to 21.5 million in 2030 (See Tables 3 and 4). In 2010, the cancers with the most new cases worldwide were lung (12.8% of new cases), breast (10.9%), colorectal (9.8%), stomach (7.8%), other sites (7.4%) and prostate (7.1%). Cancers of the lung, breast and stomach ranked highly across all country income groups, but for some other cancer sites, the pattern varied. For example, cervical cancer was responsible for 12% of new cancer cases in low-income countries, but only 1% of new cases in high-income countries.

Table 3: Lung, breast and colorectal cancers dominate
Estimated number of new cancer cases by site and country income group, 2010

	World		Low income countries		Lower-middle income countries		Upper-middle income countries		High income countries	
	Number	%	Number	%	Number	%	Number	%	Number	%
All sites*	**13,313,111**	**100.0**	**631,527**	**100.0**	**2,298,066**	**100.0**	**4,986,434**	**100.0**	**5,165,899**	**100.0**
Bladder	404,018	3.0	11,665	1.8	51,825	2.3	118,970	2.4	213,592	4.1
Brain, nervous system	247,813	1.9	8,369	1.3	49,059	2.1	111,661	2.2	75,458	1.5
Breast	1,450,792	10.9	65,916	10.4	294,075	12.8	425,749	8.5	636,356	12.3
Cervix uteri	553,236	4.2	76,034	12.0	230,069	10.0	189,401	3.8	54,326	1.1
Colorectum	1,302,167	9.8	30,720	4.9	137,469	6.0	420,221	8.4	682,243	13.2
Corpus uteri	303,458	2.3	6,026	1.0	36,683	1.6	137,308	2.8	117,729	2.3
Gallbladder	153,143	1.2	7,356	1.2	28,198	1.2	54,202	1.1	61,645	1.2
Hodgkin lymphoma	69,958	0.5	6,149	1.0	19,250	0.8	20,242	0.4	23,543	0.5
Kaposi sarcoma	35,444	0.3	25,913	4.1	6,392	0.3	3,830	0.1	11	0.0
Kidney	287,893	2.2	7,439	1.2	29,679	1.3	81,896	1.6	162,377	3.1
Larynx	159,115	1.2	8,343	1.3	43,598	1.9	57,485	1.2	47,394	0.9
Leukaemia	363,883	2.7	15,256	2.4	81,611	3.6	130,937	2.6	130,800	2.5
Lip & oral cavity	276,754	2.1	21,598	3.4	110,401	4.8	60,586	1.2	77,244	1.5
Liver	789,424	5.9	40,102	6.3	106,939	4.7	494,173	9.9	132,989	2.6
Lung	1,697,640	12.8	48,733	7.7	183,925	8.0	765,233	15.3	666,593	12.9
Melanoma	209,493	1.6	4,875	0.8	10,123	0.4	29,641	0.6	160,056	3.1
Multiple myeloma	108,504	0.8	3,080	0.5	16,149	0.7	22,521	0.5	64,811	1.3
Nasopharynx	88,275	0.7	4,980	0.8	29,280	1.3	45,562	0.9	6,878	0.1
Non-Hodgkin lymphoma	373,176	2.8	25,583	4.1	75,061	3.3	86,099	1.7	180,164	3.5
Oesophagus	508,728	3.8	31,755	5.0	76,831	3.3	318,957	6.4	75,606	1.5
Other pharynx	144,127	1.1	9,258	1.5	64,231	2.8	25,479	0.5	42,436	0.8
Other sites	987,509	7.4	91,212	14.4	299,751	13.0	290,853	5.8	294,672	5.7
Ovary	235,335	1.8	12,751	2.0	62,028	2.7	74,934	1.5	81,913	1.6
Pancreas	294,092	2.2	6,776	1.1	30,251	1.3	100,201	2.0	151,085	2.9
Prostate	950,672	7.1	18,355	2.9	65,280	2.8	207,913	4.2	643,476	12.5
Stomach	1,042,661	7.8	33,298	5.3	112,968	4.9	635,269	12.7	246,862	4.8
Testis	53,757	0.4	1,833	0.3	8,810	0.4	15,129	0.3	26,984	0.5
Thyroid	222,046	1.7	8,150	1.3	38,129	1.7	61,982	1.2	108,658	2.1

* "All sites" excludes non-melanoma skin cancer

Table 4: Cancer cases expected to increase sharply by 2030
Estimated number of new cancer cases by site and country income group, 2030

	World		Low income countries		Lower-middle income countries		Upper-middle income countries		High income countries	
	Number	%	Number	%	Number	%	Number	%	Number	%
All sites*	**21,503,563**	**100.0**	**1,141,472**	**100.0**	**3,870,173**	**100.0**	**7,971,873**	**100.0**	**7,112,007**	**100.0**
Bladder	703,119	3.3	22,042	1.9	93,429	2.4	204,257	2.6	319,316	4.5
Brain, nervous system	360,420	1.7	13,450	1.2	72,244	1.9	155,534	2.0	95,815	1.3
Breast	2,173,341	10.1	114,797	10.1	473,593	12.2	585,907	7.3	779,185	11.0
Cervix uteri	777,300	3.6	137,943	12.1	374,654	9.7	251,385	3.2	60,847	0.9
Colorectum	2,206,886	10.3	54,957	4.8	236,684	6.1	684,469	8.6	965,824	13.6
Corpus uteri	472,338	2.2	10,646	0.9	58,636	1.5	191,739	2.4	150,305	2.1
Gallbladder	260,975	1.2	14,208	1.2	49,971	1.3	97,691	1.2	90,383	1.3
Hodgkin lymphoma	91,079	0.4	10,287	0.9	27,095	0.7	24,649	0.3	26,727	0.4
Kaposi sarcoma	44,347	0.2	48,527	4.3	11,038	0.3	4,846	0.1	15	0.0
Kidney	469,378	2.2	12,524	1.1	46,377	1.2	122,126	1.5	222,276	3.1
Larynx	261,035	1.2	16,161	1.4	77,175	2.0	94,546	1.2	64,596	0.9
Leukaemia	533,482	2.5	24,369	2.1	116,745	3.0	170,352	2.1	180,331	2.5
Lip & oral cavity	437,501	2.0	41,487	3.6	189,954	4.9	96,091	1.2	103,019	1.4
Liver	1,265,485	5.9	73,033	6.4	196,247	5.1	791,253	9.9	185,736	2.6
Lung	2,893,649	13.5	90,368	7.9	334,148	8.6	1,315,405	16.5	965,719	13.6
Melanoma	328,261	1.5	9,002	0.8	15,930	0.4	42,708	0.5	207,275	2.9
Multiple myeloma	184,417	0.9	5,783	0.5	29,204	0.8	37,730	0.5	93,265	1.3
Nasopharynx	126,690	0.6	8,487	0.7	47,567	1.2	63,943	0.8	8,819	0.1
Non-Hodgkin lymphoma	583,681	2.7	43,663	3.8	124,734	3.2	130,201	1.6	249,568	3.5
Oesophagus	847,887	3.9	61,174	5.4	138,948	3.6	558,306	7.0	104,317	1.5
Other sites	1,540,906	7.2	162,771	14.3	497,801	12.9	451,438	5.7	409,915	5.8
Other pharynx	230,016	1.1	17,775	1.6	113,865	2.9	39,423	0.5	53,729	0.8
Ovary	354,220	1.6	22,181	1.9	99,956	2.6	103,162	1.3	102,697	1.4
Pancreas	505,414	2.4	12,335	1.1	52,270	1.4	168,728	2.1	215,280	3.0
Prostate	1,722,596	8.0	34,892	3.1	122,927	3.2	390,185	4.9	964,311	13.6
Stomach	1,752,329	8.1	61,808	5.4	198,778	5.1	1,096,165	13.8	342,678	4.8
Testis	66,050	0.3	2,844	0.2	11,991	0.3	18,251	0.2	26,931	0.4
Thyroid	310,761	1.4	13,957	1.2	58,213	1.5	81,386	1.0	123,129	1.7

* “All sites” excludes non-melanoma skin cancer

These estimates assume that incidence will remain stable over time and that any increases in cancer cases result from changes in population alone. Nor do they take into account changing epidemiological profiles or advances in cancer therapy that may occur between now and the year 2030. Therefore, for some cancer sites, the figures here may be an underestimate of the true burden in 2030, and for other cancer sites, these estimates may overestimate the future burden.

What about costs?
The 13.3 million new cases of cancer in 2010 were estimated to cost US$ 290 billion. Medical costs accounted for the greatest share at US$ 154 billion (53% of the total), while non-medical costs and income losses accounted for US$ 67 billion, and US$ 69 billion, respectively (See Table 5). The total costs were expected to rise to US$ 458 billion in the year 2030 (see Table 6).

Table 5: Medical costs account for the largest share of cancer costs. Estimated costs of new cancer cases by cancer site and cost component, 2010 (expressed in millions of 2010 US $)

	Medical costs	Non-medical costs	Income losses	Total
All sites*	**153,697**	**67,072**	**68,969**	**289,737**
Bladder	3,819	2,351	1,523	7,692
Brain, nervous system	3,079	1,155	580	4,814
Breast	12,182	7,085	7,379	26,646
Cervix uteri	657	534	1,472	2,664
Colorectum	17,644	6,917	7,038	31,598
Corpus uteri	1,837	1,307	1,410	4,554
Hodgkin lymphoma	687	301	450	1,438
Kidney	3,130	1,839	2,324	7,293
Larynx	845	542	553	1,941
Leukaemia	12,297	2,365	539	15,201
Lip oral cavity	1,872	1,007	893	3,772
Liver	4,176	1,700	5,773	11,648
Lung	28,877	10,903	12,068	51,848
Melanoma of skin	4,368	2,509	1,255	8,132
Multiple myeloma	3,232	1,159	225	4,616
Nasopharynx	208	104	201	512
Non-Hodgkin lymphoma	7,226	2,711	1,414	11,351
Oesophagus	2,938	1,266	2,306	6,509
Other pharynx	1,446	647	403	2,496
Other sites**	12,293	5,411	1,867	19,571
Ovary	2,915	1,021	568	4,504
Pancreas	6,165	2,541	1,867	10,573
Prostate	14,602	7,200	750	22,552
Stomach	4,295	2,603	10,242	17,141
Testis	429	253	1,213	1,895
Thyroid	720	872	4,656	6,248

* "All sites" excludes non-melanoma skin cancer; Kaposi Sarcoma not included due to lack of cost data.

** "Other sites" includes gallbladder cancer

Table 6: Lung cancer is likely to remain the most costly.
Estimated costs of new cancer cases by cancer site and cost component, 2030 (expressed in millions of 2010 US $)

	Medical costs	Non-medical costs	Income losses	Total
All sites*	**218,322**	**94,658**	**144,876**	**457,857**
Bladder	5,886	3,623	2,473	11,982
Brain, nervous system	3,975	1,491	1,095	6,561
Breast	15,278	8,886	10,896	35,060
Cervix uteri	779	633	3,239	4,651
Colorectum	25,403	9,959	11,792	47,153
Corpus uteri	2,386	1,698	2,625	6,709
Hodgkin lymphoma	802	352	630	1,784
Kidney	4,354	2,558	3,447	10,359
Larynx	1,185	760	999	2,944
Leukaemia	17,340	3,335	953	21,627
Lip oral cavity	2,567	1,381	1,434	5,382
Liver	5,870	2,390	20,510	28,770
Lung	42,940	16,212	24,048	83,201
Melanoma of skin	5,774	3,316	1,564	10,654
Multiple myeloma	4,760	1,706	327	6,793
Nasopharynx	269	135	654	1,057
Non-Hodgkin lymphoma	10,220	3,835	2,059	16,114
Oesophagus	4,219	1,817	7,868	13,905
Other sites**	17,551	7,682	3,921	29,155
Other pharynx	1,879	840	622	3,341
Ovary	3,750	1,313	930	5,993
Pancreas	8,978	3,701	3,087	15,765
Prostate	22,258	10,975	1,017	34,249
Stomach	6,019	3,648	30,500	40,167
Testis	445	263	1,510	2,217
Thyroid	835	1,012	6,677	8,525

* "All sites" excludes non-melanoma skin cancer; Kaposi Sarcoma not included due to lack of cost data.
** "Other sites" includes gallbladder cancer

There are several costs that are not included in the estimates provided here: those due to mortality, to cancer cases diagnosed before the given year, to cancer research and development or to pain and suffering. Given that these costs are not accounted for, the figures presented here underestimate the total cost of cancer in a given year. Detailed notes on data sources, methods and results can be found in the online appendix.

Cardiovascular Disease

Cardiovascular disease is an overarching term that refers to a group of diseases involving the heart or blood vessels. While there are many diseases in this classification, over 82% of the mortality burden is because of ischaemic or coronary heart disease (IHD), stroke (both hemorrhagic and ischaemic), hypertensive heart disease or congestive heart failure (CHF).

The cost of CVD in this report takes into account the cost of care for the major CVD conditions and their proximate risk factors, as well as lost productivity owing to either premature death or significantly disabling disease (see Box 5). The focus is on IHD, stroke and congestive heart failure as the leading drivers of cost through hospitalizations and need for follow-up clinical care in addition to lost productivity from premature mortality, but costs include primary prevention through hypertension and cholesterol management and screening. Previous estimates of the total cost of CVD have been calculated only for select developed and developing countries or related to a single risk factor. This report, for the first time, calculates estimates of the entire economic burden on a global scale (Gaziano et al., 2009; Lloyd-Jones, et al., 2009; Pestana, Steyn, Leiman, & Hartzenberg, 1996; WHO, 2005a).

Box 5: Cardiovascular disease model

This model divides the costs of CVD into five broad categories: screening, primary prevention, secondary prevention, acute hospital care and lost productivity. The analysis was restricted to data available for WHO regions and is meant to be as exhaustive as possible given the data available.

Productivity losses were estimated by first determining the annual expected number deaths from IHD, stroke, hypertensive heart disease and CHF. Using estimates from Leeder et al. (Leeder, Raymond, & Greenberg, 2004), which estimated the proportions of CVD deaths that are predicted to occur between the ages of 35-64, the number of deaths in each region were calculated based on these estimates using a representative country from that study for each region. Then, assuming an average age of event of 55 in this population and a value for the regional unemployment rate, the net present value of lost wages was calculated. CVD rates were assumed to be independent of employment status, which may over- or underestimate the total. In addition, lost productivity was taken into account for those with permanently disabling stroke, advanced CHF and severe angina. Finally, lost work time for seeking care in the outpatient setting and during hospitalizations was included.

The above costs were then projected for each year between 2011 and 2030, assuming the changing age demographics based on estimates from the UN Population Division. For this analysis, incidence rates, risk factor estimates, and hospitalization and treatment rates were held constant, while absolute numbers were adjusted to account for increases in the adult population.

The costs of managing hypertension and abnormal cholesterol values are addressed in this model, although diabetes management and smoking cessation are not. More details on the data sources, methods and results can be found in the online appendix.

So what are the results?
In 2010, the global cost of CVD is estimated at US$ 863 billion (an average per capita cost of US$ 125), and it is estimated to rise to US$ 1,044 billion in 2030 – an increase of 22% (see Table 7). Overall, the cost for CVD could be as high as US$ 20 trillion over the 20-year period (an average per capita cost of nearly US$ 3,000). Currently about US$ 474 billion (55%) is due to direct healthcare costs and the remaining 45% to productivity loss from disability or premature death, or time loss from work because of illness or the need to seek care.

Table 7: Cardiovascular disease costs could rise by 22% by 2030
Global costs attributable to CVD, and CVD incidence (in 1000s), selected years: 2010-2030

Year	Total cost (billions of US$)	CHF incidence	IHD incidence	Stroke incidence
2010	863	10,072	24,167	28,299
2015	906	10,821	25,933	30,370
2020	957	11,830	28,284	33,122
2025	1,002	12,754	30,369	35,571
2030	1,044	13,637	32,339	37,886

Total, all years, 2010-2030 = 20,032 (billions of US$)

On a regional basis, as Table 8 shows, the low-mortality, high-income regions – Europe and parts of the Americas – had the highest overall costs, whereas the high-mortality, low-income regions had the lowest costs.

Table 8: Richer countries currently shoulder higher costs
Costs attributable to CVD in 2010 by WHO sub-region (billions of US$, except per capita values)

WHO Region	Total Costs (without productivity costs)	Productivity Costs	Total Costs (including productivity costs)	Per capita total costs*	Per capita total costs* (adults only)
AFR-D	2.9	3.0	5.9	15	47
AFR-E	4.1	1.7	5.7	13	43
AMR-A	165.9	108.2	274.0	736	1,206
AMR-B	8.8	17.2	26.0	52	108
AMR-D	0.9	2.1	3.1	36	91
EMR-B	4.2	7.8	12.0	70	160
EMR-D	3.5	2.9	6.3	14	41
EUR-A	197.0	90.2	287.1	627	924
EUR-B	7.5	51.1	58.6	265	501
EUR-C	7.8	39.1	46.9	194	309
SEAR-B	3.8	6.1	9.9	29	59
SEAR-D	11.3	9.5	20.8	14	32
WPR-A	36.5	26.1	62.7	372	527
WPR-B	19.8	24.7	44.4	27	48
Total	473.9	389.6	863.5		

*Total costs in US$ (not in billions of US$).

Note: WHO Member States are grouped into 6 geographic regions: AFRO (Africa), AMRO (Americas), EMRO (Eastern Mediterranean), EURO (Europe), SEARO (South-East Asia) and WPRO (Western Pacific). The six WHO regions are further divided based on patterns of child and adult mortality in groups ranging from A (lowest) to E (highest): AFRO (D,E); AMRO (A,B,D); EMRO (B,D); EURO (A,B,C); SEARO (B,D); WPRO (A,B). For more information, see WHO, 2011c.

Chronic Obstructive Pulmonary Disease

The term chronic obstructive pulmonary disease (COPD) refers to a group of progressive lung diseases that make it difficult to breathe (e.g. bronchitis and emphysema). It is one of the main forms of chronic respiratory disease (which also includes asthma).

The cost-of-illness estimate for COPD represents the total direct and indirect costs for 185 WHO member countries, which constitute over 95% of the world's population as well as over 95% of the world's GDP (see Box 6).

Box 6: COPD model

The first stage of analysis involved the estimation of country-specific prevalence rates. Prevalence figures were imputed by conducting a regression including mean age, real GDP per capita, smoking prevalence in the adult population and CO_2 emission from solid fuel consumption. Prevalence was assumed to remain constant over the time period 2010-2030; however, total population varied according to population projections from the United Nations Population Division. In the literature, it is predicted that most countries will experience increases in overall COPD prevalence (Global Initiative for Chronic Obstructive Lung Disease, 2010; Halbert, Isonaka, George, & Iqbal, 2003; Mannino & Buist, 2007; Nielsen, et al., 2009). Therefore, the estimates presented here are most likely an underestimation of the true COI for COPD in 2030.

The direct cost of illness included the cost of care in the four stages of COPD (adjusted based on GDP per capita for countries where data was missing), as well as that of exacerbations, which are extremely common in stages 3 and 4 of the disease. Indirect costs include lost income due to foregone productivity of people with COPD and their family caretakers. The indirect costs and direct costs were summed and adjusted upward by 3.6%, a summary cost percentage of 'other, non-personal, indirect costs of COPD' from several other studies (The Australian Lung Foundation, 2008).

What are the costs of COPD?
The global cost of illness for COPD will rise from US$ 2.1 trillion in 2010 to US$ 4.8 trillion in 2030. Approximately half of all global costs for COPD arise in developing countries (see Table 9).

Table 9: Developing countries will share the growing COPD bill
Global Cost of Illness for COPD in 2010 and 2030. Costs shown in billions of 2010 US$

	Low - and Middle-Income Countries			High-Income Countries			World		
	Direct Costs	Indirect Costs	**Overall Cost of Illness**	Direct Costs	Indirect Costs	**Overall Cost of Illness**	Direct Costs	Indirect Costs	**Overall Cost of Illness**
2010	1,004	74	**1,077**	874	157	**1,030**	1,878	230	**2,108**
2030	2,328	255	**2,583**	2,001	212	**2,213**	4,329	468	**4,796**

Diabetes

Diabetes mellitus, commonly referred to simply as diabetes, is a metabolic disorder in which the body is unable to appropriately regulate the level of sugar, specifically glucose, in the blood. It affects a large number of individuals worldwide, with this number expected to continue to grow dramatically in the years ahead. The cost approach here takes into account direct costs, disability costs, and mortality costs (see Box 7).

Box 7: Diabetes model

Estimates of the direct cost of illness are taken from the International Diabetes Federation's *Diabetes Atlas 2010,* which reports estimates on a country-by-country basis. These estimates are based on the medical care costs of people with diabetes, above and beyond those of people without. As such, they will also reflect medical costs that are associated with other health conditions that are complications of diabetes. This report does not undertake to adjust the diabetes cost data for this component of double counting. Lost income associated with diabetes mortality is estimated based on parameter estimates in extant literature that indicate that people with diabetes lose 8% of potential work time in low- and middle-income countries, and 2% of potential work time in high-income countries. Lost income associated with diabetes mortality is estimated assuming that people who die of diabetes do not work at all in the year in which they die. Diabetes prevalence and mortality data for 2010 are also taken from the *Diabetes Atlas 2010,* as are projections of diabetes prevalence to 2030. Diabetes mortality is projected to 2030 assuming the same ratio of deaths to prevalence in 2030 as in 2010 (International Diabetes Federation, 2010).

So what are the results?
Diabetes cost the global economy nearly US$ 500 billion in 2010, and that figure is projected to rise to at least US$ 745 billion in 2030, with developing countries increasingly taking on a much greater share of the outlays.

For 2010, most of the costs were direct, more than half of which came from the United States. Of the direct costs, 90% were accounted for by countries classified as high-income by the World Bank, which have roughly 26% of the total population of people with diabetes (see Table 10). The 40% of people with diabetes in low- and lower-middle income countries, by contrast, accounted for barely 1.7% of direct expenditures.

In 2030, indirect costs will take up a much larger share than at present, mostly because of a steep rise in disability costs in upper middle-income countries (see Table 11). The overall distribution of costs is also expected to change, with the great majority of spending occurring outside of high-income countries. Nearly US$ 300 billion of direct costs are expected to come from low- and lower-middle income countries, which will constitute 45% of all diabetes cases. However, it should be noted that the 2030 overall estimate may be low because for some countries it was not possible to estimate indirect costs for 2030.

Table 10: High-income countries currently pay most of the costs of diabetes…
Cost of diabetes 2010, 2010 US$

Income Group	Direct Costs (Billions)	Disability Costs (Billions)	Mortality Costs (Billions)	# of People with Diabetes (Millions)	Direct Costs as % of World Total	Indirect Costs as % of World Total	People with Diabetes as % of World total
High	$341.5	$41.7	$5.8	74.7	90.8	49.8	26.2
Upper Middle	$28.1	$33.1	$2.1	96.1	7.5	36.8	33.8
Lower Middle	$6.0	$11.3	$0.8	97.5	1.6	12.6	34.3
Low	$0.4	$0.7	$0.1	16.2	0.1	0.8	5.7
Total	**$376**	**$86.8**	**$8.8**	**284.5**	100.0	100.0	100.0

Table 11: … but middle-income countries will take over in 2030
Cost of diabetes 2030, 2010 US$

Income Group	Direct Costs (Billions)	Disability Costs (Billions)	Mortality Costs (Billions)	# of People with Diabetes (Millions)	Direct Costs as % of World Total	Indirect Costs as % of World Total	People with Diabetes as % of World total
High	$123.6	$54.3	$7.2	92.6	25.4	24.1	21.2
Upper Middle	$55.8	$131.9	$9.5	143.7	11.5	55.4	32.8
Lower Middle	$294.5	$44.8	$4.4	170.0	60.6	19.3	38.9
Low	$12.2	$2.6	$0.6	30.9	2.5	1.3	7.1
Total	**$486.1**	**$233.6**	**$21.6**	**437.2**	100.0	100.0	100.0

Mental Illness

Mental health conditions are the leading cause of DALYs worldwide and account for 37% of healthy life years lost from NCDs (WHO, 2011a). Among these conditions, unipolar depressive disorder, alcohol use disorders and schizophrenia constitute the greatest global burden in terms of disability (see Table 12).

Table 12: Mental illness disrupts lives
Disability-Adjusted Life Years associated with mental health conditions

	DALYs (millions)	% mental health DALYs, world
All Neuropsychiatric disorders	**199**	
Unipolar depressive disorders	65	32.9
Bipolar affective disorder	14	7.2
Schizophrenia	17	8.4
Epilepsy	8	3.9
Alcohol use disorders	24	11.9
Alzheimer and other dementias	11	5.6
Parkinson disease	2	0.9
Multiple sclerosis	2	0.8
Drug use disorders	8	4.2
Post-traumatic stress disorder	3	1.7
Obsessive-compulsive disorder	5	2.6
Panic disorder	7	3.5
Insomnia (primary)	4	1.8
Migraine	8	3.9

Source: (WHO, 2008)
Note: Shaded conditions are not taken into account in this study; DALYs listed here do not include the following two categories: lead-caused mental retardation and "other" neuropsychiatric disorders.

Previous reviews have shown that strong data exist for countries like the United Kingdom, the United States and Australia, but there is a dearth of cost data for mental health expenditures in developing countries (Hu, 2004). Further, less than 70% of all WHO countries have mental health programmes, and even fewer have designated mental health budgets within their national healthcare system (WHO, 2003, 2005b). Nevertheless, lost productivity and the social burden of mental illness, even in the absence of designated mental health spending, are substantial across the globe. The lack of mental health cost studies from LMICs reflects a lack of recognition of mental illness, lack of funding, data and training (Hu, 2004).

WHO estimates that 25% of all patients using a health service suffer from at least one mental, neurological or behavioral disorder, most of which are undiagnosed or untreated. Further, there is a two-way relationship between mental illnesses and other chronic conditions: the existence of a different chronic condition (as well as HIV/AIDS) exacerbates the risk of developing a mental disorder, and vice versa. In addition to the lack of diagnosis and systematic mental health plans, mental illness suffers from societal stigma, constituting an immense barrier to treatment and access to services. Further, WHO estimates that the majority of low- and middle-income countries devote less than 1% of their health budget to mental healthcare.

In the cost-of-illness estimates reported here, as a result of the paucity of national COI estimates to ground the analysis, major assumptions are that each country in fact provides and spends funds on mental health treatment and that the disease burden is driven by population size, mean age of the population and level of economic development. Another major assumption, as is the case with all other COI estimates, is that the prevalence of mental illnesses is the same in the year 2010 as it will be in 2030 (see Box 8). Overall, the cost of mental health conditions was estimated for 184 WHO countries.

Box 8: Mental illness model

This report presents a global summary estimate of the costs of all mental health conditions. The estimated overall global cost of mental illness was partially based on data from a systematic review of the costs of overall mental illness (Hu, 2006). From this review, which included studies between 1990 and 2003, national costs for mental health conditions were included for the United States, China, Kenya and Australia. Since the publication of that systematic review, national studies of the cost of mental illness were published for Canada, the United Kingdom and France, and were included in the cost estimations.

To arrive at the global COI of all mental health conditions, existing cost estimates were converted to 2010 and 2030 estimates from their base year by multiplying the costs in the base year with an annual growth rate adjustment factor. This adjustment factor was calculated based on the average growth per year between 2000 and 2010. These estimates were regressed on real GDP per capita to impute the data missing for other countries. The estimates assume no change in prevalence from 2010 to 2030.

So what are the results?
The global cost of mental health conditions in 2010 was estimated at US$ 2.5 trillion, with the cost projected to surge to US$ 6.0 trillion by 2030 (see Table 13). About two-thirds of the total cost comes from indirect costs and the remainder from direct costs (Table 13). Currently, high-income countries shoulder about 65% of the burden, which is not expected to change over the next 20 years.

Table 13: Mental illness costs expected to more than double by 2030
Global cost of mental health conditions in 2010 and 2030. Costs shown in billions of 2010 US$

	Low- and Middle-Income Countries			High-Income Countries			World		
	Direct Costs	Indirect Costs	Total Cost of Illness	Direct Costs	Indirect Costs	Total Cost of Illness	Direct Costs	Indirect Costs	Total Cost of Illness
2010	287	583	870	536	1,088	1,624	823	1,671	2,493
2030	697	1,416	2,113	1,298	2,635	3,933	1,995	4,051	6,046

Overall, the cost-of-illness studies demonstrate the following:

(1) The current costs of NCDs are very high, ranging from hundreds of billions of US dollars to trillions of US dollars in one year alone. In spite of the differences in how the COI method was applied to the five categories of NCD, the results tell us that the current economic impact is indeed considerable.

(2) These costs are projected to grow as populations increase and age over the next two decades. Given our assumptions that rates of disease are constant over time, the projected costs presented here may be underestimates of the true future burden. Many risk factors for the major NCDs are increasing worldwide and have a delayed impact on development of disease. The effects of such changing risk factor profiles will not be seen until decades from now and are not reflected in the estimates presented here.

(3) Productivity losses due to death or disability are substantial. Productivity losses make up a sizeable portion of total NCD costs, with a considerable variation across NCDs. Given that NCDs are largely chronic, require long-term management, affect work attendance due to disability and care-seeking, and take people prematurely out of the workforce, the impact of NCDs on productivity is notable.

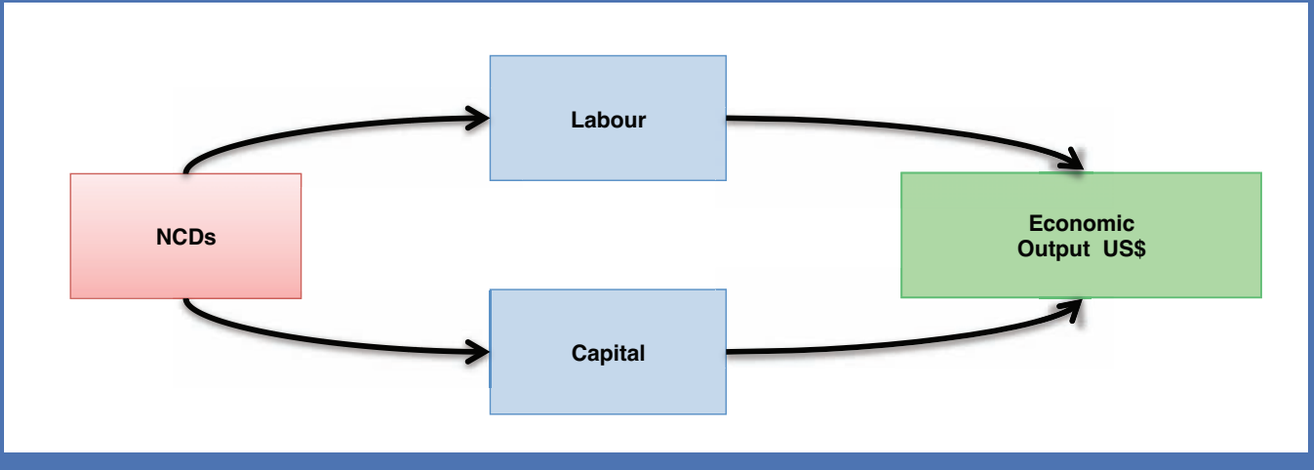
Given the strengths and weaknesses in the COI approach, two other approaches for evaluating the economic burden of NCDs are presented in the following sections.

2.2 Approach 2: Value of Lost Output

The second approach uses WHO's EPIC tool, which quantifies global economic losses from NCDs by relating projected NCD mortality rates in a population to current and future economic output at the national level (see Box 9). In this approach, the emphasis is the impact of NCD mortality on GDP.

Box 9: How the EPIC tool works

The EPIC tool was developed by the World Health Organization to simulate the economic impact of diseases on aggregate economic output (Abegunde & Stanciole, 2006). The centrepiece of the model is a standard economic growth model that relates aggregate output to capital and labor inputs, as mediated by technology. NCDs are introduced into the model by assuming they deplete both capital and labour. Capital is depleted by the diversion of savings from the increase of physical capital to healthcare consumption associated with NCDs. Labour is depleted by NCD mortality and morbidity.[11] In our study, the economic burden is estimated for five conditions in 169 countries for 2011-2030: ischaemic heart disease, cerebrovascular disease, diabetes, COPD and breast cancer. The estimates are based on WHO projections of the mortality trajectory associated with these five conditions, as well as on WHO estimates of labour force participation rates and imputed rates of technological progress constructed as part of this project.



Note: EPIC calculates lost output on a disease- and country-specific basis in 1997 international (PPP-adjusted) dollars. This report adjusts the EPIC results so that they are (a) expressed in 2010 US$ (not PPP adjusted); (b) scaled up to reflect a global total; (c) scaled up using WHO data on DALYs to reflect the four NCDs that are the focus of the UN NCD Summit; and (d) scaled up further, using WHO data on mental illness DALYs, to include estimates of economic losses from mental health conditions.

[11] The model does not allow for human capital, nor does it allow endogenous technological progress (owing to R&D spending) or the rate of savings to be influenced by NCD mortality. The model builds in an assumption that technology improves by 1% every year in every country (that is, the same labour and capital inputs will result in 1% higher output in period t+1 than in period t). The aggregate figures reported in this report are based on 169 countries. The technology parameter needed to implement the model is contained within EPIC for 101 countries. This parameter was imputed for the remaining 68 countries based on the relationship between income per capita and the technology parameter.

Four results stand out:

(1) There will be a huge global loss in output. Over the period 2011-2030, the total lost output from the four NCD conditions that are the focus of the UN High-Level meeting and mental health conditions is projected to be nearly US$ 47 trillion (see Table 14). This loss, divided by the 20-year period, is equivalent to about 5% of global GDP in 2010.

(2) Mental health conditions and cardiovascular diseases cost the most. Together, mental health and cardiovascular diseases account for almost 70% of lost output, followed by cancer, chronic respiratory diseases and diabetes (see Figure 3a).

(3) The higher the income, the higher the burden. The high-income countries bear the highest absolute burden of lost output (see Figure 3b), reflecting their high income (which is lost when people are sick). Upper-middle-income countries (a group that includes China) have the second highest burden, followed by lower-middle income (a group that includes India). Low-income countries have the lowest burden because the value of lost earnings in this group is low and the total population of this group is much smaller than that of the middle-income countries.

(4) By 2030, total output losses will soar. Cumulative NCD losses will of course steadily rise over the next 20 years, but the rate of increase will pick up sharply by 2030. (see Figure 4)

Table 14: The anticipated economic toll of NCDs is staggering
Economic burden of NCDs, 2011-2030 (trillions of US$ 2010), based on EPIC model 1[12]

Country income group	Diabetes	Cardiovascular diseases	Chronic Respiratory diseases	Cancer	Mental Illness*	Total
High	0.9	8.5	1.6	5.4	9.0	25.5
Upper-middle	0.6	4.8	2.2	2.3	5.1	14.9
Lower-middle	0.2	2.0	0.9	0.5	1.9	5.5
Low	0.0	0.3	0.1	0.1	0.3	0.9
LMIC	**0.8**	**7.1**	**3.2**	**2.9**	**7.3**	**21.3**
World	**1.7**	**15.6**	**4.8**	**8.3**	**16.3**	**46.7**

*The numbers for mental illness were obtained by relating the economic burden of all other diseases to their associated number of DALYs. Then the burden for mental illness was projected using the relative size of the corresponding DALY numbers to all the other conditions.

[12] This study uses the 2011 World Bank classifications distinguishing low-, middle- and high-income countries, with middle-income countries further subdivided into lower-middle and upper-middle. Categorization depends on a country's gross national income per capita. This report refers to low-, lower-middle- and upper-middle-income countries collectively as LMICs.

Figure 3a: Mental health and cardiovascular diseases are top drivers of lost output
Breakdown of NCD cost by disease type, based on EPIC model

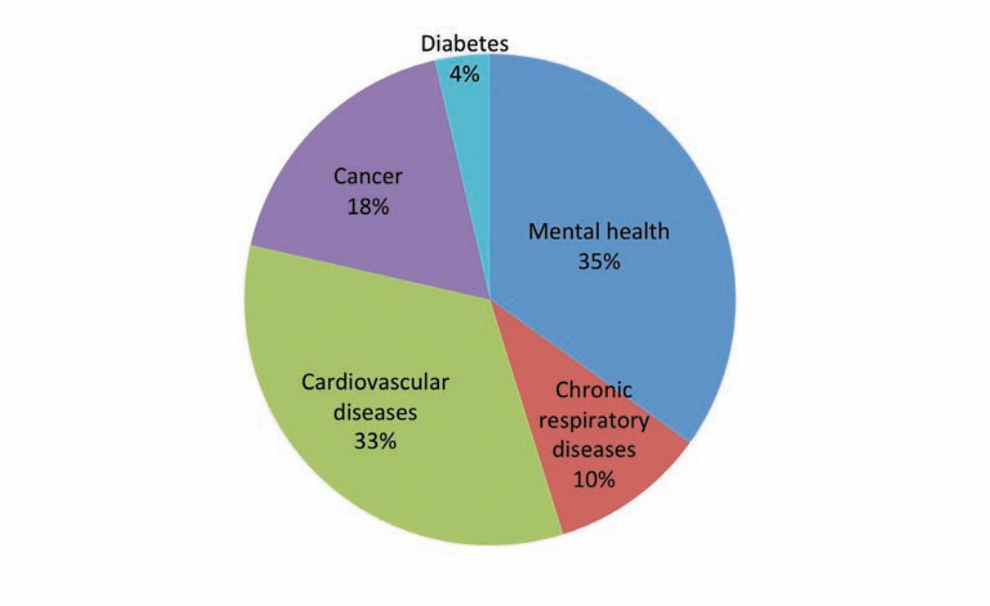


Figure 3b: High-income countries lose the most output
Breakdown of NCD cost by income level, based on EPIC model

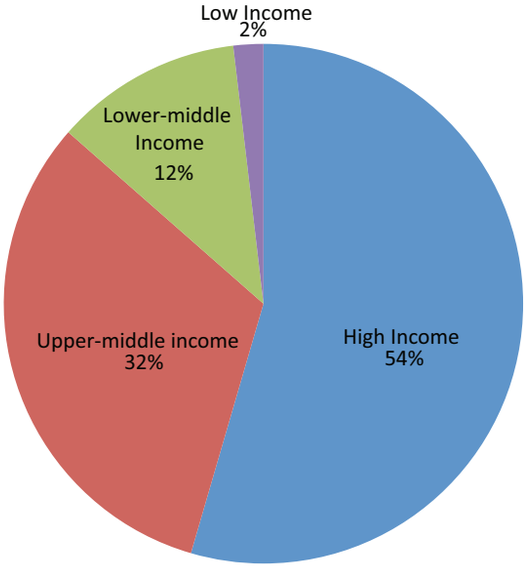
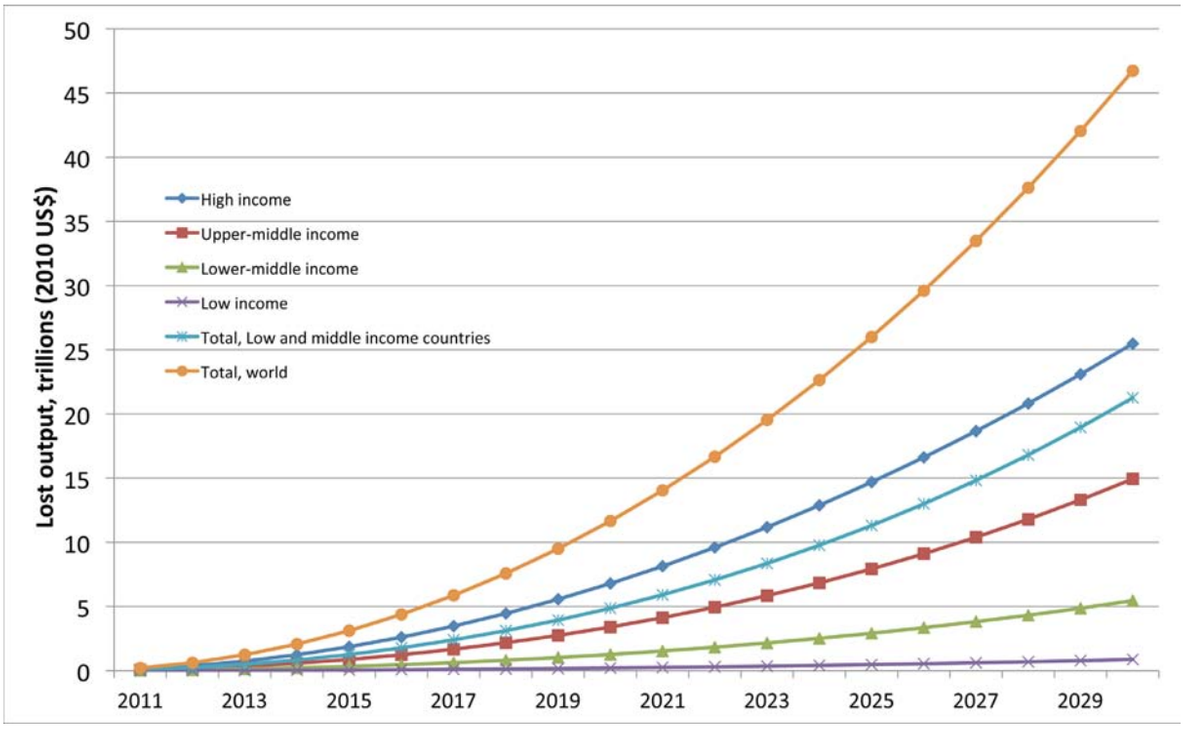


Figure 4: Output losses will speed up over time (Breakdown of NCD cost by disease, based on EPIC model)



2.3 Approach 3: Value of a Statistical Life

Tradeoffs between risks and money – and the fact that people make these every day in many facets of their lives – is the key insight underlying the value of statistical life (VSL) approach to estimating the cost of ill-health (Johansson, 2001). The wage premium someone receives to accept a job with an abnormally high risk of injury or death is one example of such a tradeoff. The extra amount of money someone spends to consume a healthier diet is another. The VSL approach quantifies the relationship between money and the risk of disability or death. The quantification is done either by analyzing observed tradeoffs (as is done in labour market studies that relate wage levels to injury risks) or hypothetical preferences (as in surveys that ask people how much they would be willing to pay to avoid a particular risk or how much money they would require to take on that risk).

Take the case of a pool of homogeneous workers who face two job opportunities (A and B) that are identical in all ways except that one job (A) has an annual occupational-fatality risk of 3 in 10,000, while the other job (B) has a corresponding fatality risk that is lower: 2 in 10,000. Suppose further that the annual market wage for job A is $500 more than for job B. The rate of compensation for risk is commonly expressed as a "value per statistical life". In this example, VSL = $5 million (= $500/[(3-2)/10,000]). Since workers in job B are willing to pay US$ 500 per year for the lower risk of mortality, 10,000 such workers would together be willing to give up US$ 5 million per year to prevent one expected death among them.

In principle, the VSL approach accounts for lost income (post-tax), out-of-pocket spending on (or related to) medical care and the cost people associate with pain and suffering and the intrinsic value of life (see Box 10). This contrasts with the COI and EPIC approaches, neither of which account for pain and suffering or the intrinsic value of life. In addition, the COI and EPIC approaches, in principle, focus on output losses pre-tax and different aspects of medical care costs.

Box 10: How the VSL approach works

The VSL approach is used to estimate the economic burden of NCDs in 2010 and to project that burden in 2030. Separate analyses are conducted for five specific NCDs: cardiovascular disease, chronic respiratory diseases, diabetes, cancer and mental health; and also for a category of all NCDs. In terms of 2004 DALYs, the five conditions – CVD, COPD, diabetes, cancer and mental health – account for 55% of all NCD DALYs. The aggregate figures reported in the accompanying tables are based on the 155 countries for which the requisite data are available. Omitted countries tend to have extremely small populations.

Constructing the VSL estimates/projections requires the estimation of DALYs in 2010 and 2030. This was done by (1) fitting a zero-intercept cross-country regression of DALYs for the six different categories of health conditions in 2004 (the most recent year for which data are available) on 2004 population (and its square), the share of population aged 65+, and GDP per capita in 2004 (in exchange rate terms); (2) estimating GDP per capita in 2010 (2030) by applying the average annual growth rate during 2000-2009 to GDP per capita in 2005; and (3) using the estimated parameters from the regression to extrapolate 2004 DALYs to 2010 and 2030.

An alternative (rule-of-thumb) approximation for directly valuing DALYs is also implemented. This approximation was originally suggested by the WHO Commission on Macroeconomics and Health. It recommends valuing DALYs at between one and three times GDP per capita (referred to as CMH1 and CMH3, respectively) (World Health Organization, 2001). Constructing the CMH1 and CMH3 estimates/projections simply involves multiplying 2010 and 2030 DALYs by the relevant multiple (1 or 3) of income per capita in 2010 and 2030, respectively. The per capita GDP for 2010 and 2030 was obtained by extrapolating the mean rate of growth over the last 10 years and using the latest available actual numbers (for the year 2009) from the World Development Indicators database as a basis for the projection.

Constructing the VSL estimates/projections requires estimating VSL for a large group of countries. This is done by regressing VSL estimates (in US$ 2000) for 12 countries reported in Viscusi and Aldy (Viscusi & Aldy, 2003) on GDP per capita (in US$ 2000) and life expectancy at birth (from the UN Population Division). The parameter estimates are then applied to estimates of GDP per capita in 2010 (2030) and life expectancy data in 2010 (2030) for all countries to impute VSL estimates for countries where no studies existed in Viscusi and Aldy (Viscusi & Aldy, 2003). The GDP per capita estimates for 2010 and 2030 are calculated using the same procedure as described in the notes to the CMH calculations.

The VSL data are taken to be the value of life of a representative median-aged member of the corresponding national population. For example, consider a population in which life expectancy at birth is 80, median age is 30, and VSL is US$ 3 million. Suppose further that a 50 year old dies unexpectedly and suddenly. This death contributes 30 DALYs, and an economic loss of US$ 1.8 million (= [30/(80-30)] * US$ 3 million).

The CMH1, CMH3 and VSL figures reported herein may be interpreted as the total future cost of incident NCD cases in 2010 (2030).

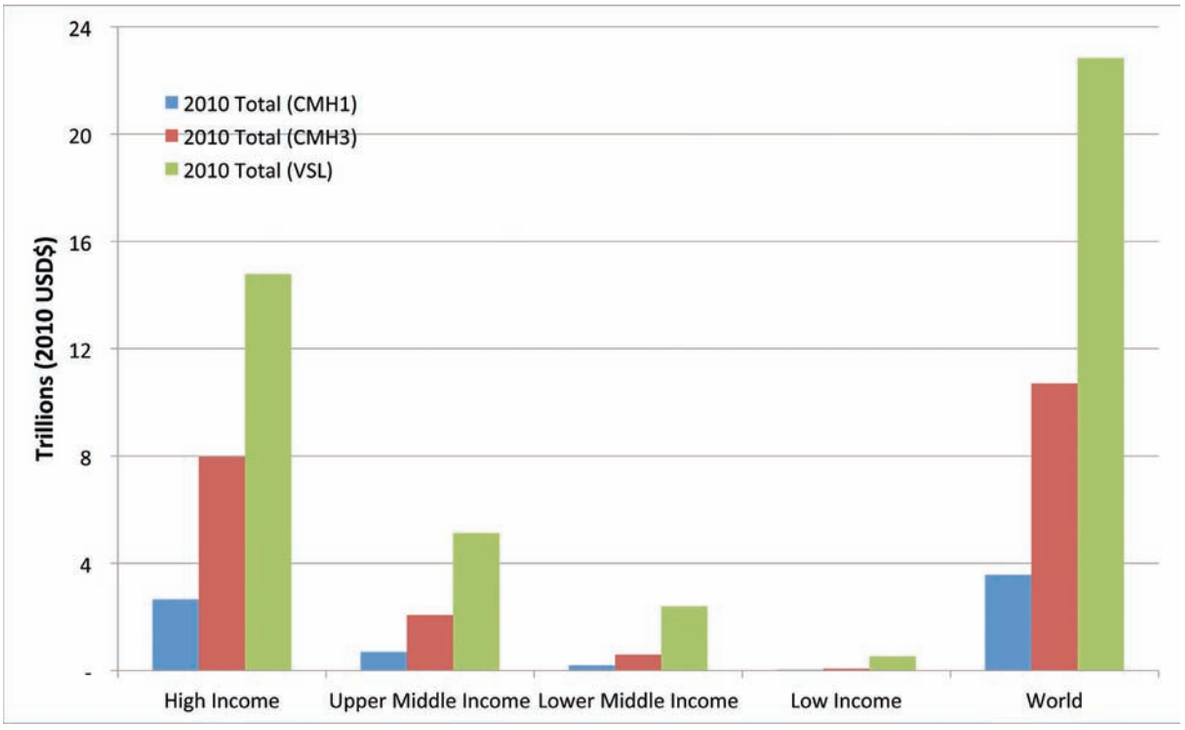
What did the VSL approach show for the economic burden of NCDs? Three results stand out:

(1) The economic burden of life lost because of NCDs will double from 2010 to 2030, as measured by three very different yardsticks (see Figure 5). That said, the economic burden estimates vary widely, by a factor of more than 6– from 2010 US$ 3.6 to 22.8 trillion in 2010, and from 2010 US$ 6.7 to 43.4 trillion in 2030. The upper end of these estimates looms exceedingly large, representing a notable and growing fraction of 2010 GDP, but even at the lower end, these estimates for 2010 and 2030 are sizable (Table 15).

(2) High-income countries will bear the biggest burden. In 2010, high-income countries will bear the dominant share of lost output, reflecting their high income and relatively older populations. But the upper-middle-income countries will take on a much bigger share in 2030 – owing to the size and growth of their income and their overall and older populations – beginning to rival the high-income countries (Figure 6).

(3) Mental illness and cardiovascular diseases are the largest problems. By disease, mental illness will account for the largest share of the economic burden in both 2010 and 2030, just slightly greater than cardiovascular diseases (Table 16). They are followed by cancer, chronic respiratory disease and diabetes.

Figure 5: NCD cost burden likely to double by 2030 (CMH1, CMH3 and VSL estimates*)



*The CMH1 method refers to multiplying DALYs by one times GDP per capita; the CMH3 method refers to multiplying DALYs by three times GDP per capita.

Table 15: By all measurements, the cost burden will be sizable
Value of life lost due to NCDs, by estimation method and income group (trillions of 2010 US$)

	2010 Total (CMH1)	2030 Total (CMH1)	2010 Total (CMH3)	2030 Total (CMH3)	2010 Total (VSL)	2030 Total (VSL)
High Income	2.7	3.4	8.0	10.3	14.8	19.7
Upper Middle Income	0.7	2.6	2.1	7.8	5.1	17.4
Lower Middle Income	0.2	0.6	0.6	1.9	2.4	5.3
Low Income	0.0	0.1	0.1	0.2	0.5	1.0
World	3.6	6.7	10.7	20.2	22.8	43.4

Figure 6: Upper middle-income countries will take on a bigger share of lost output
Comparison of VSL losses in 2010 and 2030, to 2010 GDP, by income group (trillions of 2010 US$)

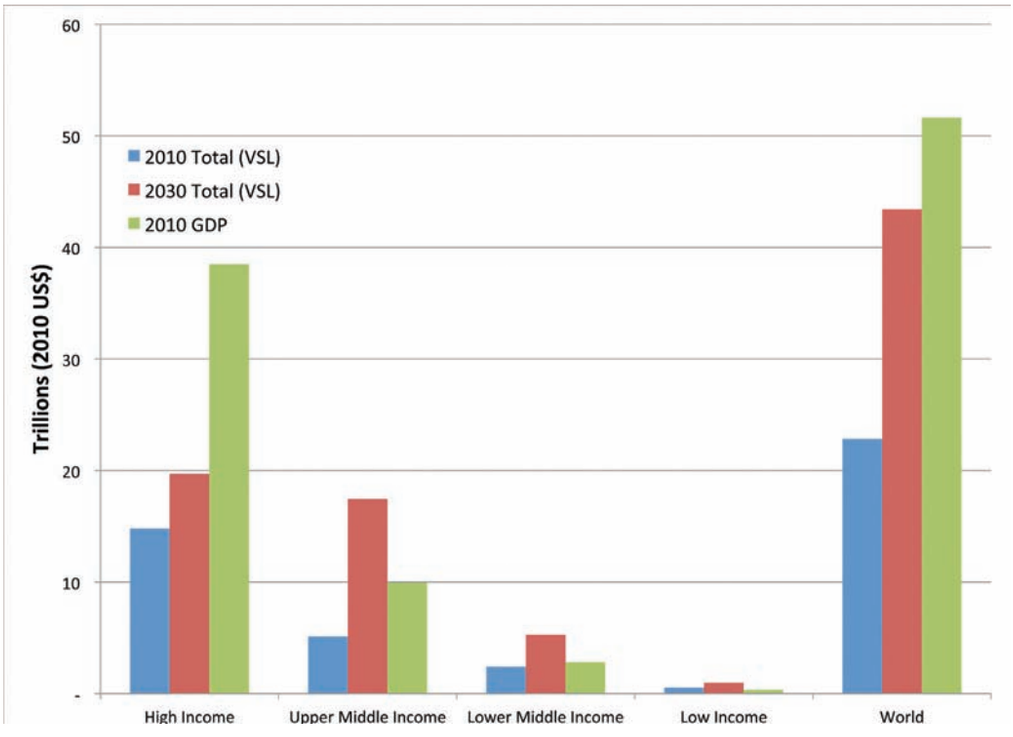


Table 16: Mental illness hits output hard
Breakdown of output losses by disease type and income category, 2010 and 2030, trillions (2010 US$), using the VSL approach

	2010						2030					
	Cancer	Chronic respiratory disease	Cardio-vascular diseases	Diabetes	Mental Illness	Total	Cancer	Chronic respiratory disease	Cardio-vascular diseases	Diabetes	Mental Illness	Total
High Income	1.7	1.5	5.4	0.7	5.5	14.8	2.2	2.0	7.2	1.0	7.3	19.7
Upper Middle Income	0.6	0.5	1.9	0.3	1.9	5.1	1.9	1.8	6.3	0.9	6.5	17.4
Lower Middle Income	0.3	0.2	0.9	0.1	0.9	2.4	0.6	0.5	1.9	0.3	2.0	5.3
Low Income	0.1	0.1	0.2	0.0	0.2	0.5	0.1	0.1	0.4	0.0	0.4	1.0
World	**2.5**	**2.4**	**8.3**	**1.2**	**8.5**	**22.8**	**4.9**	**4.5**	**15.8**	**2.2**	**16.1**	**43.4**

3. Conclusion

The health community and the business community are both concerned about the burden of NCDs and its likely growth in coming decades. By contrast, this issue is just barely on the radar screen of economic policy-makers, who most often do not see that NCDs pose a threat to development, economic growth and poverty alleviation.

If this report is correct in its assessment of the economic threat posed by NCDs, then the evidence it has marshalled will be useful to the world's economic leaders – top government officials, including finance ministers and their economic advisors – who control large amounts of spending at the national level and who have the power to react to the tremendous economic threat posed by NCDs. Two points are key here:

First, in economic terms, NCDs matter significantly. At the national level, treatment expenses can be high and the loss of labour due to chronic disease can make a substantial dent in a country's productive capacity. Ongoing improvements in economic well-being can be seriously impeded by widespread chronic disease.

Second, the human and economic burdens of NCDs can both be contained by devoting resources directly or indirectly to prevention, screening, treatment and care. In other words, health spending is not predominantly consumption. A large portion of health spending is appropriately viewed as investment – one that yields a handsome rate of return.

The key premise of this report is that expressing the burden of NCDs in dollar terms – not just human terms – gives economic leaders the ability to consider the effects of NCDs in terms that they most often use. And the evidence is clear: NCDs impose a substantial economic burden today, which will evolve into a staggering economic burden over the next two decades (see Box 11).

Box 11: The NCD cost tally

Three different approaches were applied to estimate this burden, and although *none of the results are comparable* for reasons described above, all approaches yield dauntingly large numbers.

- Cost-of-illness approach: estimates of direct and indirect costs of ill health for five distinct disease categories are:
  - Cancer: an estimated US$ 290 billion in 2010 rising to US$ 458 billion in 2030.
  - Cardiovascular disease: an estimated US$ 863 billion in 2010 rising to US$ 1.04 trillion in 2030.
  - COPD: an estimated US$ 2.1 trillion in 2010 US$ rising to US$ 4.8 trillion in 2030.
  - Diabetes: an estimated nearly US$ 500 billion in 2010 rising to at least US$ 745 billion in 2030.
  - Mental illness: an estimated US$ 2.5 trillion in 2010 rising to US$ 6.0 trillion by 2030.
- EPIC approach: lost output from five conditions (cancer, cardiovascular disease, chronic respiratory diseases, diabetes and mental health) over the period 2011-2030 is estimated at nearly US$ 47 trillion.
- VSL approach: the economic burden of life lost due to all NCDs ranges from US$ 22.8 trillion in 2010 to US$ 43.3 trillion in 2030.

Who bears the economic burden? This study shows that although high-income countries bear the highest absolute cost currently, the developing world – especially upper middle-income countries – will be assuming a large share of the tab as their economies and populations continue to grow and their populations age. These hefty sums can be put in perspective by looking at health outlays. World expenditure on health in 2009 totalled US$ 5.1 trillion (US$ 754 per capita)[13], of which 61% was spent by public entities. The vast majority of this expenditure (US$ 4.4 trillion) took place in high-income countries, where spending per capita was US$ 3,971 and the share of public spending was 62% of the total. At the other end of the spectrum, low-income countries spent an average of US$ 21 per capita, of which 42% was supplied by public entities. And if trillions still seem unfathomable, Box 12 shows some further comparisons.

Box 12: Putting trillions into context

Estimates in the trillions of dollars can be brought down to earth by making simple comparisons. Where this report refers to costs in a single year, the relevant comparisons are single-year costs. In this respect, it is interesting to note that total global health spending in 2009 was US$ 5.1 trillion, and the entire annual GDP of low-income countries is less than US$ 1 trillion.

For those figures that express NCD costs over a 20-year period, a useful comparison is that 2.5 billion people living on less than US$ 2 per day would need US$ 18 trillion in transfers to bring them above the poverty line for 20 years (assuming that each, on average, needs US$ 1 to reach the US$ 2 per day level). Even more striking is the fact that the total amount of overseas development assistance delivered during the past 20 years is less than US$ 2 trillion.

It is important to reiterate that, for several reasons, the various methods for estimating the economic burden of NCDs yield results that are not comparable to each other. It is equally important to highlight the fact that implementing each of these methods required us to make numerous assumptions – assumptions that can be challenged and that we cannot test. Nevertheless, the results presented here give a sense of the magnitude of the economic burden of NCDs. Further refinement of methods, and better data, will be needed to obtain a more reliable sense of the cost of NCDs. Understanding these costs is crucial in judging the priority of addressing NCDs.

Research is also needed into the net future benefits of NCD interventions aimed at prevention, early detection, treatment and care. These net benefits will depend on the implications of alternative interventions for (1) the length and quality of additional years of life, (2) employment, earnings and pension recipiency during those additional years, (3) the cost of the interventions, and (4) medical and non-medical care costs associated with other health conditions that will eventually ensue. The results will also depend on whether one adopts a social or private perspective, the degree of tolerance for uncertainty and risk, and the relative value placed on short-term versus longer-term costs and benefits.

So, how should NCDs be tackled? There is no shortage of knowledge with respect to the best ways to do this. Dietary changes (for example, reduced consumption of salt and increased consumption of fruit and vegetables); increased physical activity; cessation of smoking and harmful use of alcohol (perhaps by increased tobacco and alcohol taxes, and through information, education and communication campaigns); and transforming medical training to address the changing nature of disease burdens are all options to prevent and manage NCDs, including mental illness. Increasingly, the literature is pointing to the potential of mental health interventions to improve clinical and economic outcomes in low- and middle-income countries (Lund, et al., 2011; Patel, et al., 2011). Of course, many other interventions may also contribute to the effort to reduce NCDs (World Health Organization, 2004, 2010a, 2010b).

It will be essential to involve a wide range of stakeholders in the implementation of interventions. The private sector, in particular, has a key role to play. For example, private industry can develop new technologies to prevent, diagnose and treat NCDs, market healthy products and make existing food products healthier. Also, setting priorities is a must, given that in most countries resources for health are very limited. For policy-makers, that will mean taking into consideration the current and projected burden of disease, cost-effectiveness of proposed interventions, the equity of and relative feasibility of competing options and short-term political considerations.

In response to this need, in the lead-up to the UN High-Level Meeting in mid-September 2011, WHO has assembled evidence on different interventions and identified a set of “best buys” that are cost-effective, feasible and appropriate for use in LMICs (see Table 17) (WHO, 2011a). It is also providing a costing tool to enable countries to assess substitute interventions that fit national circumstances.

[13] These and other cost figures throughout this report are expressed in 2010 US$.

Table 17: "Best Buy" interventions for NCD prevention and control

Risk factor / disease	Interventions
Tobacco use	• Tax increases • Smoke-free indoor workplaces and public places • Health information and warnings • Bans on tobacco advertising, promotion and sponsorship
Harmful alcohol use	• Tax increases • Restricted access to retailed alcohol • Bans on alcohol advertising
Unhealthy diet & physical inactivity	• Reduced salt intake in food • Replacement of trans fat with polyunsaturated fat • Public awareness via mass media about diet and physical activity
Cardiovascular disease (CVD) and diabetes	• Counseling and multi-drug therapy for people with a high risk of developing heart attacks and strokes (including those with established CVD) • Treatment of heart attacks with aspirin
Cancer	• Hepatitis B immunization to prevent liver cancer *(already scaled-up)* • Screening and treatment of pre-cancerous lesions to prevent cervical cancer

This list of "best buy" interventions for NCD prevention and control can be complemented by efforts to reduce the burden of NCDs on individuals and families. In particular, design and implementation of more cost-effective models of care (perhaps ones that rely less on family members and more on trained professionals) may make a substantial difference to those most immediately affected by NCDs.

A final thought: Economic policy-makers are naturally concerned about economic growth. The evidence presented in this report indicates that it would be illogical and irresponsible to care about economic growth and simultaneously ignore NCDs. Interventions in this area will undeniably be costly. But inaction is likely to be far more costly.

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