The Impact of Health on Worker Attendance and Productivity in the APEC Region

Final Report

ABAC/LSIF Study

Victoria Institute of Strategic Economic Studies
Victoria University
Melbourne
July 2014

2014
Victoria Institute of Strategic Economic Studies
Victoria University
PO Box 14428
Melbourne VIC 8001
For further information contact:
Peter Sheehan
peter.sheehan@vu.edu.au

Table of Contents

List of Tables ii

List of Figures ii

Executive Summary 1

Context of the Study 5

- Population ageing 5
- Indicators of the prevalence of diseases: Age-adjusted mortality rates 6
- The economic and social costs of NCDs 8

Population and Labour Force Ageing 8

- Population ageing 8
- Labour force impacts 10

Current and Future Prevalence of NCDs 12

- Trends in mortality and morbidity 12
- Trends in risk factors 15
- Conclusions on risk factors and mortality/prevalence assumptions 19

Estimating the Worker Attendance and Productivity Costs of NCDs 20

- Modelling methodology 20
- Summary estimates 22
- Interpreting the estimates 24

Estimates and the Broader Cost Picture 26

Appendix: Evidence from Countries 28

- Australia 28
- United States 29
- China 31
- Malaysia 34
- Peru 35
- The Philippines 37

References 38

List of Tables

Table ES1 Estimates of lost GDP from NCD deaths, absenteeism and presenteeism, six APEC economies, to 2030 ..3
Table 1 Simple classification of costs of NCDs 8
Table 2 Disability weights and absenteeism and presenteeism assumptions, six APEC economies 20
Table 3 Labour force increase due to deaths averted, 2010 to 2030, at constant mortality rates (persons) 22
Table 4 Labour force increase due to deaths averted, reduced death rates 2010 to 2030 (persons) 22
Table 5 Increase in annual GDP due to increase in labour force, constant mortality rates to 2030 (US$ billion)......23
Table 6 Increase in annual GDP due to increase in labour force, reduced death rates 2010 to 2030 (US$ billion)...23
Table 7 Increase in GDP due to reduction in absenteeism and presenteeism, six APEC economies 24
Table 8 Estimates of lost GDP from NCD deaths, absenteeism and presenteeism, six APEC economies, to 2030....25
Table A1 Disease and loss of productivity, Australia, 2009-10 29
Table A2 Expenditure for selected conditions, United States, 2011 31
Table A3 Losses from disease, China, 2012-2030 32
Table A4 Studies on impact of disease, China 33
Table A5 Total per-patient societal costs of asthma by country, 2006 35
Table A6 Estimated-persons-days of work lost due to illness per adult household member, Peru, 1988 36
Table A7 Summary of economic costs, US$ attributed to 4 smoking-related diseases, the Philippines, 2003 (US$=PhP 52) 37

List of Figures

Figure ES1 Change in the share of total population and labour force aged 45 years and over, six economies, 2010-30 (percentage points) 1
Figure ES2 Age-standardised mortality rates by cause, six APEC economies, 2012 (deaths per 100,000 persons).....2
Figure ES3 Indexes of the estimated real GDP lost from NCD deaths and non-fatal prevalence, six APEC economies, (indexes 2010=100) 3
Figure 1 Share of population aged 45 years and over, six APEC economies, 1980-2030 (projected) 5
Figure 2 Age-standardised mortality rates by cause, six APEC economies and Japan, selected years (deaths per 100,000 persons) 7
Figure 3 Measures of the extent and timing of population ageing, six APEC economies, 1990-2010 and 2010-30 (projected), change in share of population in individual age groups (percentage points) 9
Figure 4 Share of labour force aged 45 years and over, six APEC economies, 1980-2030 (projected) (%) 10
Figure 5 Increase in the share of the labour force age 45 years and over, six APEC economies for period 2010-30, (percentage points) 11
Figure 6 Age standardised death rates from communicable diseases, six APEC economies, 1990 and 2010........13
Figure 7 Age standardised death rates from non-communicable diseases, six APEC economies, 1990 and 2010....13
Figure 8 Age standardised YLD rates from non-communicable diseases, six APEC economies, 1990 and 2010 14
Figure 9 Smoking rates, males, per cent of population, six APEC economies, 1980 to 2012 16
Figure 10 Mean systolic blood pressure rates, males, six APEC economies, 1980 to 2008........16
Figure 11 Mean total cholesterol rates, males, six APEC economies, 1980 to 2008 17
Figure 12 Diabetes prevalence, males, per cent of population, six APEC economies, 1980 to 2008 18
Figure 13 Mean BMI, males, kg/m^2, six APEC economies, 1980 to 2008 19
Figure 14 Indexes of the estimated real GDP lost from NCD deaths and non-fatal prevalence, six APEC economies, (indexes 2010=100) 25
Figure A1 Optimal BMI for employment 33
Figure A2 Illness and hourly wages, male and female, II trimester, Peru, 1998........36

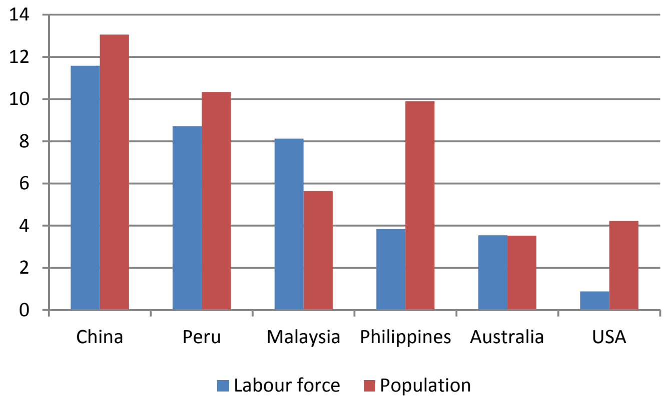
Executive Summary

Many countries in APEC face serious challenges from the intersection of population ageing and the rising incidence of non-communicable diseases (NCDs). These factors will lead, in some economies, to declining populations of workforce age and to poorer health for many actual or potential workers. The rapid economic growth achieved in many developing economies over recent decades has been driven in part by strong growth in a healthy labour force. This can no longer be relied upon, with the new trends implying an increasing incidence of poor health in a workforce that is growing more slowly, if at all. As such, these trends have important implications for the availability and productivity of labour, and are on a scale that could challenge the foundations of continued growth for many economies.

This study for the APEC Business Advisory Council (ABAC) and the Life Science Information Forum (LSIF) assembles the available empirical evidence, for six APEC economies, on the impact of health on worker attendance and productivity, and documents the limited information available on the current prevalence and expected future incidence of key NCDs for these economies. On this basis it provides a preliminary analysis of the future potential impact of NCDs on worker attendance and productivity, to provide a knowledge base for more effective policy responses to this challenge.

All six economies studies show pronounced evidence of population and labour force ageing, both up to the present and out to 2030. While the patterns of ageing are diverse and differ across economies, they can be illustrated by the increase in the share of the total population or labour force in the older age-groups over 2010-30 (Figure ES1). By this measure the ageing of the population is most pronounced in China, Peru and the Philippines, in each of which 10 percentage points or more of the population to is expected to shift into the older cohorts. But Malaysia shows more rapid ageing than the Philippines in terms of the labour force. All four of the developing economies need to deal with rapid ageing ahead. This is especially true for China, where the population of workforce age is likely to peak in the near future.

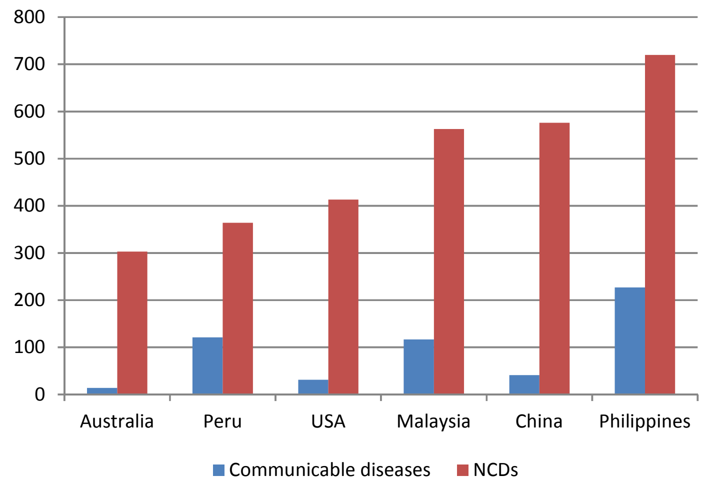
Figure ES1 Change in the share of total population and labour force aged 45 years and over, six economies, 2010-30 (percentage points)



Source: VISES estimates based on ILO (2014).

The second factor is the high level of mortality rates for NCDs (age standardised) evident in most of the six economies, their relative stability over time and the threat posed by high risk factors in many economies. Figure ES2 shows these rates for both communicable diseases and for NCDs for 2012, with high rates for NCDs in Malaysia, China and the Philippines, and also, given its level of development, in the USA. While communicable diseases have long been the scourge of developing countries, NCDs now pose a major threat as populations age and risk factors remain high.

Figure ES2 Age-standardised mortality rates by cause, six APEC economies, 2012 (deaths per 100,000 persons)



Source: WHO (2014).

In analysing the costs to economies out to 2030, we concentrate only on economic costs in the narrow sense that they are included in GDP as currently measured, while recognising that there are many real and important social costs that should also be addressed. Even within economic costs we focus on reduced ability to work in the paid labour force and reduced productivity while at work. But increased prevalence of NCDs might impact on GDP in other ways also. For example, the costs of treating and caring for people with NCDs are high and growing rapidly. It is likely that some significant part of these costs will be met from individual or public savings, hence reducing the ability of the economy to fund new investment and growth. Some estimates suggest that these dynamic costs from reduced investment, which are excluded here, may be of a comparable magnitude to those which we do address.

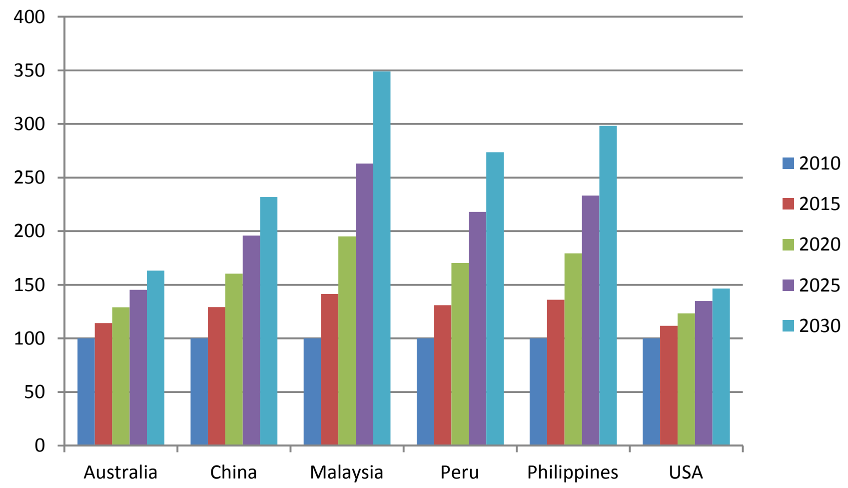
Table ES1 summarises the overall estimates of the costs in terms of lost GDP from deaths, absenteeism and presenteeism arising from NCDs for the six economies. These preferred estimates are based on the assumption of a 1% per annum decline in age standardised mortality rates from NCDs from 2010 levels in each economy out to 2030, and stable age standardised NCD prevalence rates at 2010 levels to 2030 for each economy. For the two larger economies, the USA and China, the annual cost in real 2010 terms, reaches $1.14 trillion and $485 billion by 2030, or 5.5% and 4.3% of GDP in that year respectively. The costs in 2030 for the other economies range from 4.9% of GDP for Australia to 6.1% of GDP for Malaysia. These are very large figures by any standard.

Table ES1 Estimates of lost GDP from NCD deaths, absenteeism and presenteeism, six APEC economies, to 2030

	2010	2015	2020	2025	2030
			($billion)		
Australia	51.9	59.3	67.0	75.4	84.7
China	209.5	270.6	336.1	410.2	485.7
Malaysia	11.5	16.3	22.5	30.4	40.3
Peru	7.3	9.6	12.5	15.9	20.0
Philippines	10.6	14.4	19.0	24.7	31.6
USA	779.9	872.2	963.0	1051.5	1142.6
			(share of GDP – %)		
Australia	4.5	4.7	4.8	4.8	4.9
China	3.5	3.8	4.0	4.2	4.3
Malaysia	4.6	4.7	4.9	5.0	6.1
Peru	4.9	5.1	5.2	5.3	5.4
Philippines	5.3	5.5	5.6	5.7	5.8
USA	5.2	5.4	5.5	5.5	5.5

Source: VISES estimates.

Figure ES3 Indexes of the estimated real GDP lost from NCD deaths and non-fatal prevalence, six APEC economies, (indexes 2010=100)



Source: VISES estimates.

Figure ES3 expresses the real GDP lost for each economy as an index with a base at 2010=100, and hence shows the comparative growth in real costs across the economies. The costs rise particularly steeply for the three developing countries other than China, in each case reflecting the specific characteristics of the economy. Malaysia has both rapid labour force age and high NCD mortality rate (as well as high and in some cases rising NCD risk factors) so it faces a rapid rise in NCD costs and high risks generally in relation to NCDs. The Philippines is in a similar situation, with high and by some measures rising NCD mortality rates but less rapid labour force ageing. In both these cases the cost estimate, based on constant prevalence rates, could prove to be an underestimate if the NCD situation deteriorates further.

Peru is an interesting case, with falling NCD mortality rates over 2004-2012 and generally low risk factors, but rapid labour force ageing. This gives Peru a strongly rising NCD cost out to 2030 but if this could prove to be an overestimate if progress on NCDs continues.

China has already experienced strong population ageing, but more is to come out to 2030. Its age standardised mortality rate from NCDs remains high, and many of its NCD risk factors are high and/or rising. But the burden of disease data we are using suggests that China has a much lower rate of non-fatal prevalence of NCDs than the other economies, and this leads to a lower cost as a share of GDP in 2030. Further detailed work on NCD prevalence in China, on the impact of poor risk factors and on the impact of poor health on worker attendance and performance is necessary to produce more robust estimates.

The two developed economies in our sample, Australia and the USA, differ from the other countries in several respects. The ageing of the labour force has already occurred, although mitigated in part but net immigration, and further ageing of the labour force out to 2030 is limited. But this in part means that the costs of ageing and NCDs are felt beyond the prime working years, rather than that they are avoided altogether. For these economies it may be that the dynamics costs through the impact of treatment costs on savings and investment are particularly high.

Overall these estimates confirm that the six economies face, in different ways and to different degrees, severe economic costs and broader health challenges from the intersection of high NCD incidence and population ageing. This is not a ground for pessimism, but does highlight the need for governments to give much higher priority to large scale programs to address the challenges of NCDs. After all, unprecedented levels of technology, expertise and medical practice are now available around the world, and there is a vast array of international experience demonstrating which programs are effective and which are not. There is also the experience of non-communicable diseases, whose incidence has most countries been reduced to only a fraction of what it was only 50-60 years ago, to demonstrate what can be achieved if health problems are given appropriate priority.

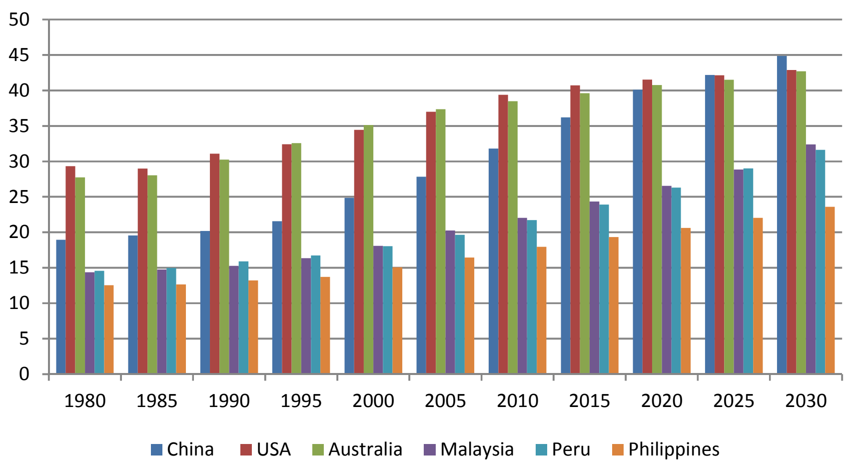
Context of the Study

In spite of very different circumstances, most APEC economies face three challenges in common: their populations are ageing, in different ways and to different degrees; there is an existing high prevalence of non-communicable diseases (NCDs), such as heart and respiratory disease, stroke, cancer and mental illness; and many risk factors for the future incidence of NCDs are high, and in some cases continuing to rise. Taken together these factors already impose heavy costs on business, governments and individuals, and threaten much greater costs in the future. This report sets out an initial attempt to understand, and quantify, the economic dimension of these costs out to 2030, for six APEC economies: Australia, China, Malaysia, Peru, the Philippines and the USA. This section sets out the broad context of the study, before the more detailed analysis is reported in the succeeding sections.

Population ageing

Many factors contribute to population ageing, most notably cyclical or secular fluctuations in the birth rate and increasing life expectancy at birth. The total fertility rate (TFR: in any given year the number of children that a hypothetical woman would have if she experienced throughout her lifetime the age-specific fertility rates prevailing in that year) was close to 3 in the developed world in the 1950s, but fell to about 1.5 by 2000, before subsequently recovering a little. In the 1950s, the TFR was close to 6 in most parts of the developing world, but again has fallen sharply at different times and at different rates across countries, to be close to or below 2 in most parts of the developing world by 2012. Death rates, especially those from communicable or infectious diseases, have also fallen rapidly in most countries, especially in the developing countries where they were a major constraint on population growth.

Figure 1 Share of population aged 45 years and over, six APEC economies, 1980-2030 (projected)



Source: United Nations (2014).

Given different patterns in the fall in both fertility rates and death rates across economies, the pattern of ageing also differs greatly across economies. Another important factor is the extent of net overseas migration, whether inwards or outwards. Most migrants tend to be relatively young, so that strong net immigration (as in Australia and the USA) tends to modify the impact of ageing, by providing an influx of younger than average people. Equally, strong net emigration can accentuate the effects of ageing, as those leaving tend to be younger than average.

While no single indicator can capture the diversity of ageing patterns, which are discussed further in the next section, Figure 1 provides one summary indicator, the proportion of the population that is aged 45 years and over. The chart provides actual data for 1980-2010 and projections out to 2030 using the central case of the latest UN population projections (United Nations 2014). The chart shows two distinct patterns of ageing relevant to this study: that in Australia, the USA and China; and that in Malaysia, Peru and the Philippines. In Australia and the USA, the share of the population 45 years and over was already close to 30% by 1980, and rose to nearly 40% by 2010, as the post-war 'baby boomers' moved through middle age. Reflecting early fertility control policies and effective action on infectious diseases, China's 45 years and over share was nearly 20% by 1980 and has risen strongly to reach 33% by 2010. Driven by these trends and without the mitigating effect of significant net overseas immigration, the share of the population aged 45 years and over continues to rise in China through to 2030 (and probably beyond), reaching 45% at that time.

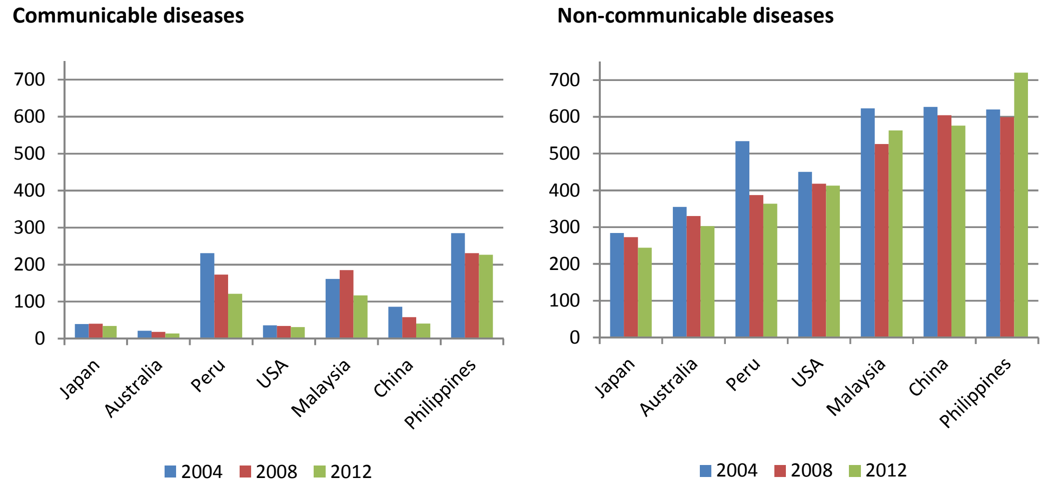
The other three economies show, by this indicator, a steady pattern of ageing, but at a lower level. In all three cases, the share of the population aged 45 years and over increases strongly over the period shown in Figure 1, to over 30% in both Malaysia and Peru by 2030, and to about 23% in the Philippines. One measure of the rate of ageing is the rise in the share of those 45 years and over for a given period, say from 2010-2030. By this measure the highest rate of ageing over 2010-30 is in China (13.6 percentage points rise in the 45+ share), Malaysia (10.3 ppts rise) and Peru (9.9 ppts rise). These three economies face a sharp rise in the share of their populations in the older age groups between now and 2030. By contrast ageing is well advanced already in Australia and the USA, with modest further increases, while in the Philippines the main impact will be beyond 2030.

Indicators of the prevalence of diseases: Age-adjusted mortality rates

Many diseases, both communicable diseases and NCDs, prove to be fatal, but in many other cases those with the disease survive, with or without some continuing disability. TB can be fatal, but need not be. Many who have a severe stroke die, but many others survive and in some cases recover fully. Mental illness is not often directly life-threatening, but can generate severe and sustained impairment. As a result the prevalence of NCDs – the number of people with that disease in a given period – is difficult to measure. For most diseases other than cancer, there are no official registries of all cases of the disease, and our knowledge of the prevalence of many NCDs is limited, even in the most advanced countries. But the causes of death are well-recorded, and hence there are good data on the number of deaths due to NCDs.

Figure 2 provides age-adjusted mortality rates for communicable diseases and NCDs for the six economies being studied here, together with Japan, the country with the highest life expectancy rates in the world, as a comparator. Because death rates from a given disease differ greatly by age, it is necessary to compare mortality rates across countries on an age-adjusted basis, using age weights drawn from a reference population. This introduces some further complications, which are taken up in the next section.

Figure 2 Age-standardised mortality rates by cause, six APEC economies and Japan, selected years (deaths per 100,000 persons)



Source: WHO (2014).

Figure 2 brings out a number of points relevant to this study. First, it illustrates the scale of NCD mortality relative to that for communicable diseases by 2012, even for developing countries. In the Philippines, for example, the age-adjusted mortality rate from communicable disease was just over 200 per 100,000 persons, whereas for NCDs it was over 700 per 100,000 persons. Secondly, while death rates from communicable diseases still vary markedly across countries, for all seven economies they have fallen steadily over the period of eight years shown. But for four of the six APEC economies shown – USA, Malaysia, China and the Philippines – NCD mortality rates have been broadly stable at a high level in recent years. In both Malaysia and the Philippines, the NCD mortality rate was significantly higher in 2012 than in 2008.

In terms of trends over the period shown, two economies stand out. One is the USA, where the NCD mortality rate remained above 400 per 100,000 people in 2012, well above the rate in most developed economies such as Japan and Australia. The second is Peru, where mortality rates from both types of disease have fallen strongly over the 2004-2012 period. While mortality rates from communicable disease remain relatively high in Peru, especially relative to China, by 2012 NCDs age-adjusted mortality rates in Peru were lower than those in the USA and well below those in China.

In spite of the limitations of this metric, these data illustrate the scale of the challenge presented by NCDs to APEC economies, and some of the variations across those economies.

The economic and social costs of NCDs

The value of a healthy year of life to an individual or to a community has many dimensions, as do the benefits foregone or the costs incurred by the loss or impairment of that healthy life year as a result of disease. Some benefits foregone or costs incurred are economic, even in the narrow sense that they are included in GDP as currently measured. These include the elements which are the particular focus of this study, namely reduced ability to work in the paid labour force and reduced productivity while at work. But increased prevalence of NCDs might impact on GDP in other ways also. For example, the costs of treating and caring for people with NCDs are high and growing rapidly. It is likely that some significant part of these costs will be met from individual or public savings, hence reducing the ability of the economy to fund new investment and growth. Table 1 provides a simple classification of the various costs of NCDs.

Table 1 Simple classification of costs of NCDs

Economic costs	Social costs
Lost working time from premature death	Loss of years of life
Lost working time (absenteeism)	Loss of the quality of life
Lost productivity while at work (presenteeism)	Broader community costs of mortality
Treatment and carer costs	Broader community costs of ongoing morbidity
Savings and investment impact of resources directed to treatment and care	

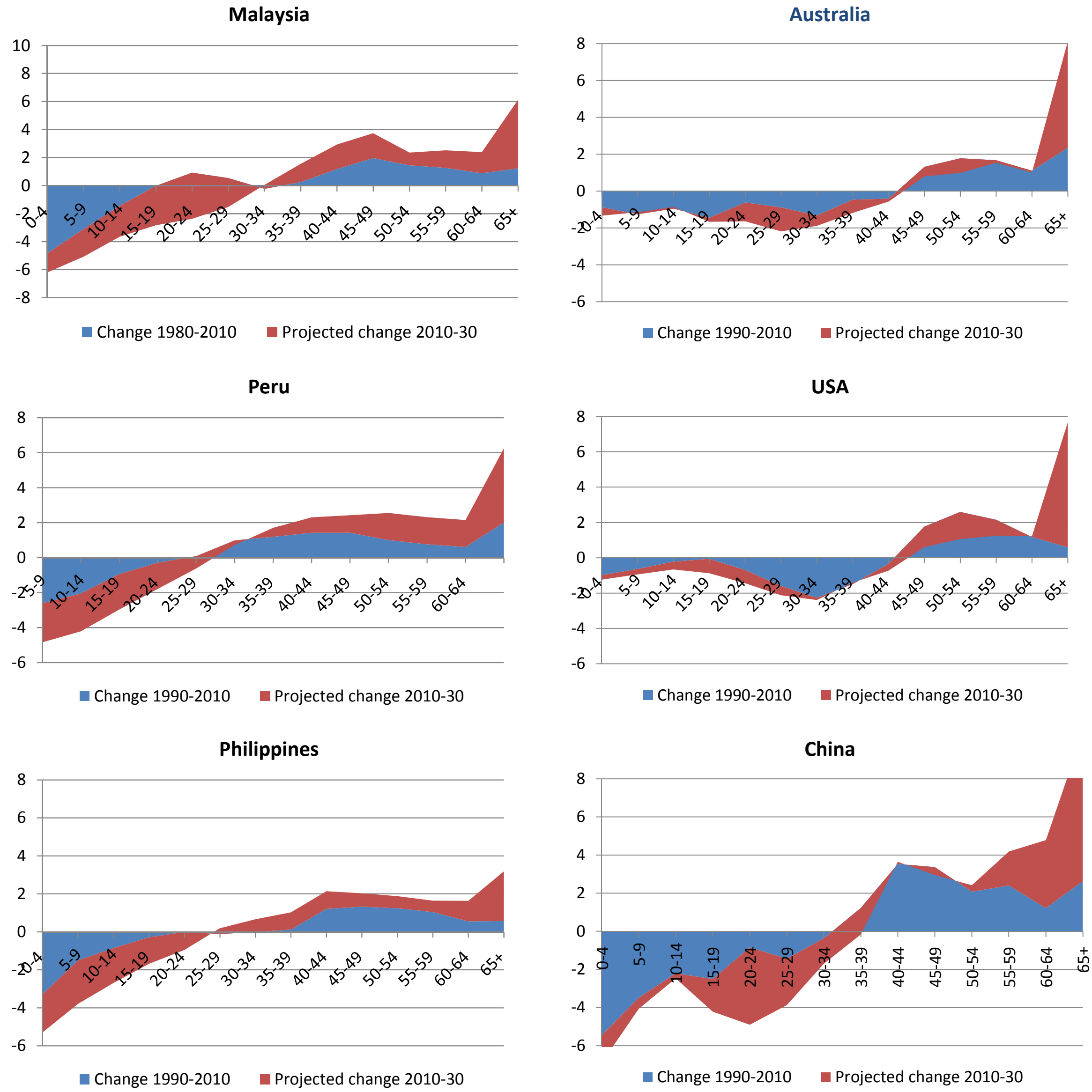
Many of the values foregone or costs incurred will not, however, be reflected in GDP figures, but will nevertheless be very real to the individual and the community. If a young mother dies from breast cancer or is seriously impaired by another disease, this is not only a great loss to her personally, but will have longer term ramifications for her family and for the broader community of which she is part. If a man in prime age gets a serious mental disease, this may impose many broader costs on his family, on the community (for example through disruption due to anti-social behaviour) and on his carers. All of these costs should be included in a full economic analysis, but here we concentrate only on economic costs in the more limited sense of inclusion in GDP, and within that only on the first three economic costs shown in Table 1.

Population and Labour Force Ageing

Population ageing

Figure 1 above illustrated the nature and diversity of ageing in the six economies by use of a single indicator, the share of the population 45 years and over at any time. It is necessary to look beyond this measure to understand the ways in which the pattern of ageing is likely to influence the economic cost arising from a given burden of NCDs. Because we are focusing on work attendance and productivity costs, the ageing that is particularly relevant is that among persons of working age, that is aged 15 years or more until about 65 years. To analyse these effects more closely, Figure 3 shows for each economy the change in the share of the population in each age group over two periods over 20 years – 1990-2010 and 2010-30. The change is measured in percentage points of the total population for the economy, with the change during 1990-2010 shown in blue and the projected change during 2010-30 shown in red. The six component charts of Figure 3 are set on the same scale to facilitate comparison.

Figure 3 Measures of the extent and timing of population ageing, six APEC economies, 1990-2010 and 2010-30 (projected), change in share of population in individual age groups (percentage points)



Source: VISES analysis of data from United Nations (2014).

These data again highlight two groups of countries. In Australia, USA and China ageing was well advanced by 2010, with falls in the population share in Australia and the USA in all age groups up to 40-44 years during 1990-2010, and in all age groups up to 30-34 years in China. In both cases the increase in the aged population over 2010-30 is concentrated in the over 65 year and over group, although in the USA there are substantial increases in the population shares in the age groups from 45 years to 59 years.

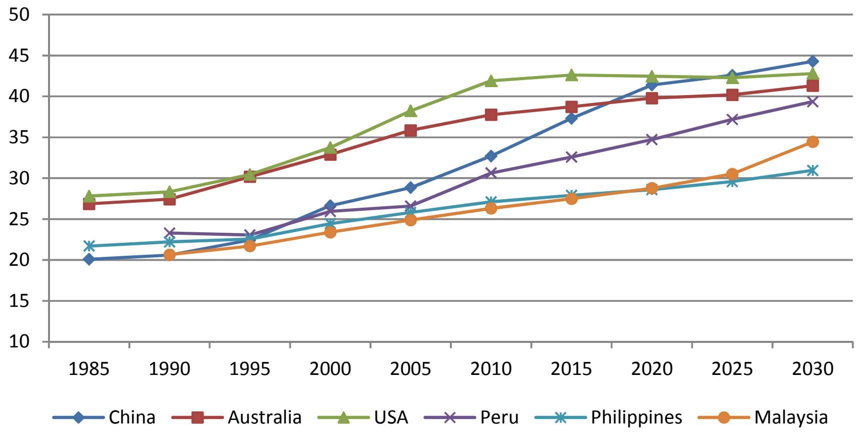
China stands out as having the strongest ageing profile among the six economies, for both periods. Over the 1990-2010 period, there was a sharp rise in the population shares for age groups from 40-60 years, at the expense of sharp falls in the pre-school and school years. Over the projection period, the big falls in population shares are in the 15-29 year age groups, while the rise in shares is mainly from 55 years and over. This means that, while there will still be significant labour force effects, the strongest growth will be in the population 65 years and over. This is also the case for Australia and USA.

Of the other economies, Malaysia and Peru show significant ageing over 1990-2010, with declines in population shares at the youngest age groups and increases in shares across age groups from the middle or late 30s onwards. They also face pronounced further ageing over 2010-30, with future changes in the age distribution of the population to the post-35 years age group and a rising share in the 65 years and over group. The Philippines also shows ongoing ageing, but at a more modest pace than either Malaysia or Peru.

Labour force impacts

From our limited perspective in this study, the key aspect of ageing is how the population of working age is changing. As explained further below, in this study we make use of labour force data and projections out to 2030 from the International Labour Office (ILO). Reverting to our earlier summary measure, Figure 4 shows the actual and projected shares of the labour force aged 45 years and over. By 2010 this share was already quite high in the USA (41.9%) and in Australia (37.8%), and is projected to rise only modestly (to 42.8% and 41.3% respectively) out to 2030.

Figure 4 Share of labour force aged 45 years and over, six APEC economies, 1980-2030 (projected) (%)



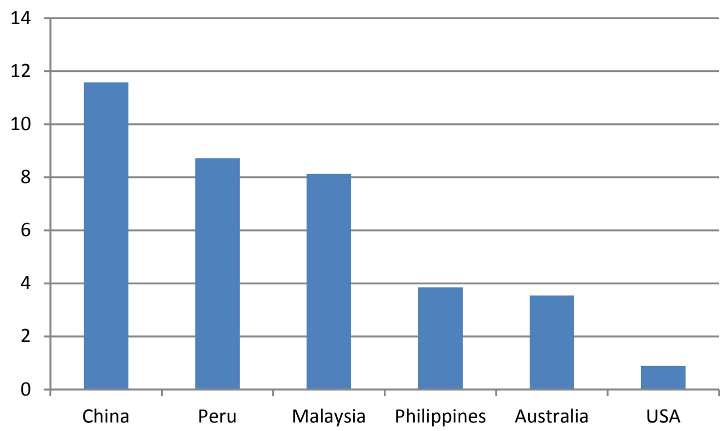
Source: ILO (2014).

In China the 45+ share of the labour force has been rising steadily since 1995, rising by more than 10 percentage points from 22.4% in 1995 to 32.7% in 2010. This increase is projected by the ILO to continue through to 2030, with the Chinese share reaching 44.3% by that time. This sharp shift in the age composition of its labour force means that China is at risk of adverse effects if high prevalence rates for NCDs continue to apply through to 2030. Peru is in a similar position with a rapidly ageing labour force, not far behind that of China. Peru's 45+ share reached 30.6% in 2010, but is projected to rise to nearly 40% by 2030.

Up to 2010 Malaysia had the youngest labour force of the six economies, by this measure, with only 26.3% in that year aged 45 years and over. This may reflect the relatively low workforce participation of women after the prime child-bearing years in that economy. But the underlying increase in this share is expected to accelerate significantly, especially after 2020, with Malaysia's 45+ labour force share reaching 34.4% by 2030. With the youngest population and the slowest rate of ageing among the developing economies being studied, the Philippines 45+ labour force share reaches only 31.0% by 2030.

Finally, Figure 5 shows the summary measure of the rate of ageing as it affects the labour force for the six economies, namely the increase in the share of the labour force that is 45 years or over for the period 2010-30, measured in percentage points of the total labour force. An increase of 10 percentage points in this measure means that 10% more of the labour force is now to be found in the over 45 years age group.

Figure 5 Increase in the share of the labour force age 45 years and over, six APEC economies for period 2010-30, (percentage points)



Source: ILO (2014).

This measure confirms our earlier analysis, and highlights the fact that three economies are particularly at risk, given the changing age structure of their labour force, to economics costs from NCDs, namely China (where the over 45 years labour share rises by 11.6 percentage points over 2010-30), Peru (where the rise is 8.7 ppts) and Malaysia (with a rise of 8.1 ppts).

Current and Future Prevalence of NCDs

To assess the economic cost associated with non-communicable diseases, it is necessary to have some measure of how many people are affected by these diseases and their severity. The data on the number of people who die due to a particular disease is usually sourced from death registrations, which record the cause of death and other characteristics of the person such as their age, sex and location. The coverage and reliability of death registrations varies from country to country, but is usually sufficient to produce reasonably good estimates of the numbers of deaths due to particular diseases by age and sex.

Estimating the non-fatal morbidity due to particular diseases, i.e. their non-fatal prevalence, is more difficult. In some countries registries are maintained for certain diseases, such as cancer and infectious diseases. For most non-communicable diseases however, prevalence estimates must rely on information collected from a variety of sources such as national health surveys, medical insurance databases, and information collected from hospitals and primary care clinics. This means that prevalence estimates can be sporadic and infrequent in many countries, especially those with developing health systems. If the only source of information is self-reported data from a national health survey, this relies on people knowing they have a disease and being able to describe their condition accurately.

A number of organisations attempt to quantify the burden of disease in a particular country or set of countries by combining information on deaths or mortality with that on morbidity using prevalence measures. The most recent such estimates for Australia are for the year 2004-05 and the WHO has produced estimates for each country for the years 1990, 2000 and 2004. The most recent set of estimates for 2010 have been done by a team of researchers based at the Institute for Health Metrics and Evaluation (IHME) at the University of Washington. Their initial results were published in *The Lancet* in 2012 (Murray et al. 2012) and further sets of estimates continue to be released.

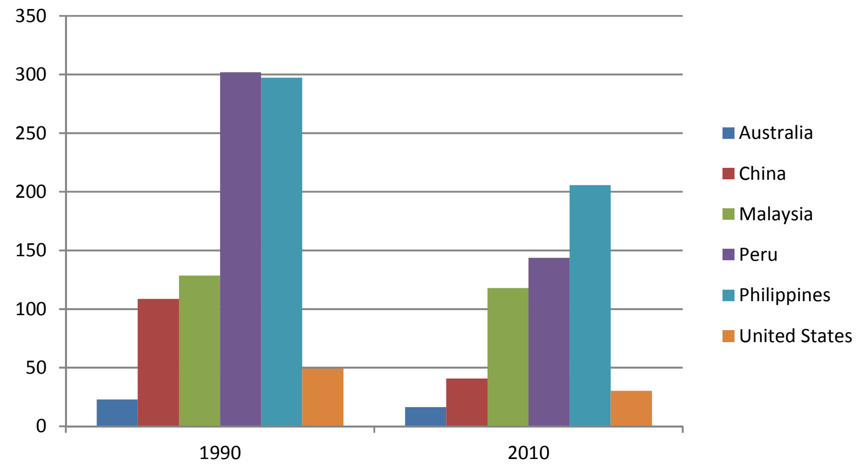
It is possible to download information from their website on the 2010 burden of disease for the six economies considered in this study. This includes the number and rates of deaths by cause by age and sex. It also includes estimates of the number of disability life years (DALYs), which is a measure combining the deaths data and morbidity data. In estimating the latter, the researchers estimated the number of years lived with disability (YLD), which is defined as the prevalence of a disease multiplied by a disability weight reflecting the severity of the disease.

Unfortunately it is not possible to obtain yet from the IHME the underlying prevalence measures used to construct the YLD estimates. For the purposes of this study, we have therefore taken the country-specific YLD estimates by age and sex and produced estimates of prevalence using the disability weights which are publicly available (Salomon et al. 2012).

Trends in mortality and morbidity

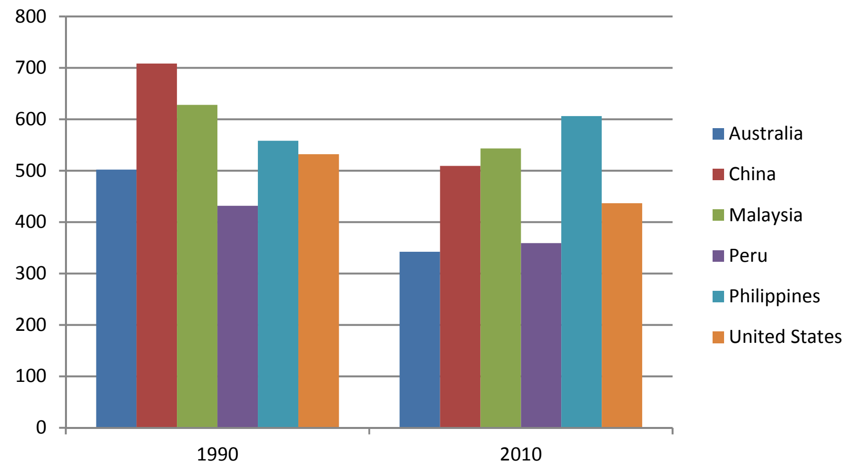
The 2010 global burden of disease study published estimates of mortality and morbidity for all countries for the years 1990 and 2010. These data allow us to place the estimates of mortality by cause provided in Figure 2 in a longer time frame, and to consider inferred prevalence data. Again we use age-standardised rates to remove the effect of different age structures on death rates across countries. But they also highlight some of the data problems that researchers face in this area. While the years for which data are available are not the same, there are indications of some significant differences in mortality rates between the WHO data used in Figure 2 and the global burden of disease data used in Figures 6, 7 and 8.

Figure 6 Age standardised death rates from communicable diseases, six APEC economies, 1990 and 2010



Source: IHME (2010).

Figure 7 Age standardised death rates from non-communicable diseases, six APEC economies, 1990 and 2010

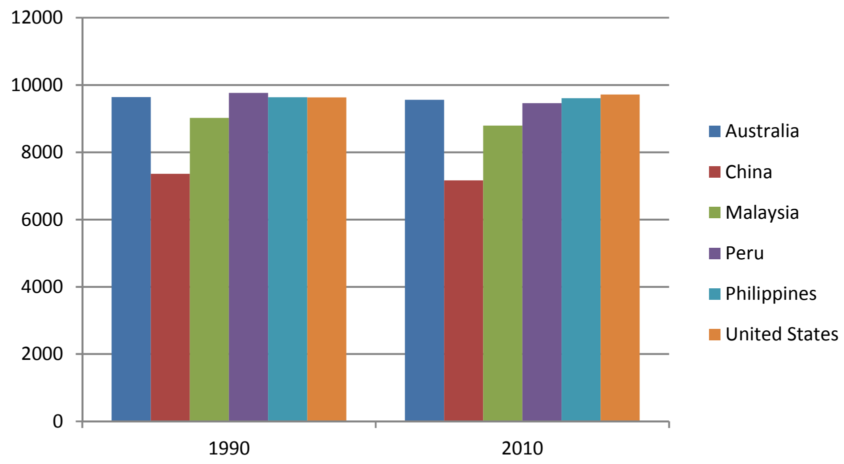


Source: IHME (2010).

The data on deaths rates from communicable disease shown in Figure 6 confirm the broad measures of Figure 2: the substantial reductions in China to low levels by 2010; strong falls in Peru and the Philippines, the rate falling by half in Peru and by a third in the Philippines over 1990-2020, although still remaining at a high level in both countries; and only a small fall in this rate in both Malaysia and the USA, where the rate remains high for the level of development in both economies in 2010.

Figure 7 complements Figure 2 above by providing a longer term perspective on age standardised death rates from NCDs, but also brings out some of the data issues with the two sources. Given the advances in medical technology and practice over the two decades from 1990, the reductions are modest in most cases, including in the USA, and mortality rates rose in the Philippines. The annual rate of decline ranged from 1.9% in Australia and 1.6% in China to 1.0% in the USA, 0.9% and 0.7% in Peru and Malaysia respectively, while for the Philippines there was an increase of 0.4% per annum. The smaller reductions over these two decades in some developing economies may reflect in part the rise in NCD risk factors in many economies over the past decade, which is discussed below.

Figure 8 Age standardised YLD rates from non-communicable diseases, six APEC economies, 1990 and 2010



Source: IHME (2010).

The best measures we have of non-fatal prevalence of NCDs over this time frame are derived from the age standardised YLD rates produced by the IHME researchers. As noted above, these are produced as the product of estimated disease-specific prevalence, by age and sex, weighted by the disability weight for each disease and age-standardised. As such this YLD rate for a given economy can change as a result of various factors: for example, changes in the non-fatal prevalence of individual diseases over time (which might in turn reflect changes in the incidence of new cases or changes in survival rates from existing cases) or changes in the composition of NCD prevalence across diseases with different disability factors.

The data presented in Figure 8 show a remarkable picture of stability, with little change in the age-standardised rate YLD rate for NCDs in any of the six economies over the two decades, in spite of the sharp falls in the NCD death rates for five of the six economies shown in Figure 7. While this stability over the period is compatible with considerable variation within it, both more effective medical treatment to increase survival rates and deteriorating risk factors for many NCDs may help to explain the long run stability of the YLD rate. Recent trends in risk factors are of concern in most countries, and are reviewed briefly below. The relatively low YLD rate for China derived from these data is of note, and is important in the cost estimates developed below.

Trends in risk factors

Certain risk factors increase the probability that a person will develop non-communicable diseases such as cardiovascular disease and cancer. The major risk factors include smoking tobacco, an inadequate diet, physical inactivity, high blood pressure (hypertension), high levels of cholesterol, being overweight and being diabetic. Trends in these risk factors can provide some insight into the prevalence of major disease.

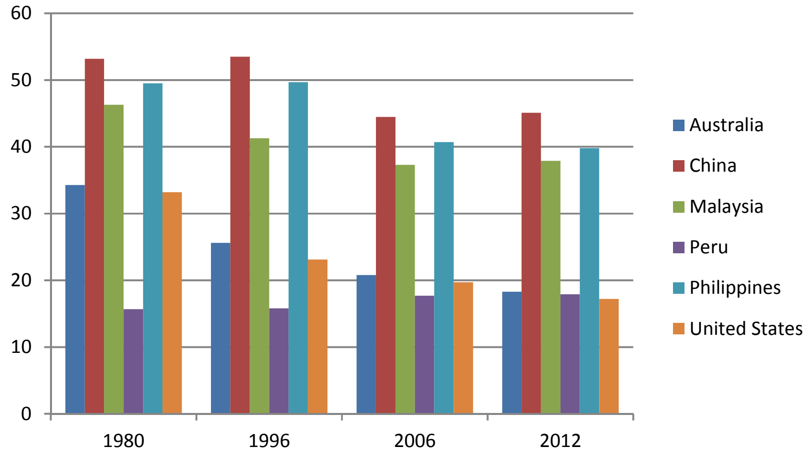
In the same way as with morbidity, information on risk factors is patchy, particularly for developing countries, with the most common source being periodic national health surveys and one-off epidemiological studies. However, a number of researchers have attempted to provide as much information as possible on trends in the major risk factors. A number of articles in *The Lancet* in 2011 presented estimates for the years 1980, 1990, 2000 and 2008 of trends in systolic blood pressure (Danaei et al. 2011a), serum total cholesterol (Farzadfar et al. 2011), body mass index (Finucane et al. 2011), and fasting plasma glucose and diabetes (Danaei et al. 2011b). More recently Ng et al. (2014) have estimated smoking prevalence for the years 1980, 1996, 2006 and 2012. Given the data issues discussed above, these figures must be regarded as the best estimate possible by analysing the available data sets, rather than in any sense definitive figures, but we provide below a review of the findings of these and related studies.

Smoking

Smoking rates remain high, especially for men, in many developing countries, and especially in Asia. Figure 9 shows that, in terms of male smoking behaviour, our six economies break into two distinct groups. In three – China, Malaysia and the Philippines – smoking rates for males remain close to or above 40% in both 2006 and 2012, after falling significantly between 1996 and 2006. By comparison, male smoking rates in Australia and the USA were lower than in these countries in 1986 and have fallen steadily since that time, to be down to 17-18% by 2012. In Peru male smoking rates were low in the 1980s and, in spite of a modest rise since then, remain below 20% in 2012.

These persistently high smoking rates among men in the three Asian developing economies present a serious and ongoing health challenge to those economies. However, smoking rates among women in China, and in some other developing countries, are low; lower than in Australia and the USA, where females smoking rates are reasonably close to those for males. Thus citing only the male rates understates the smoking problem in the two advanced economies.

Figure 9 Smoking rates, males, per cent of population, six APEC economies, 1980 to 2012

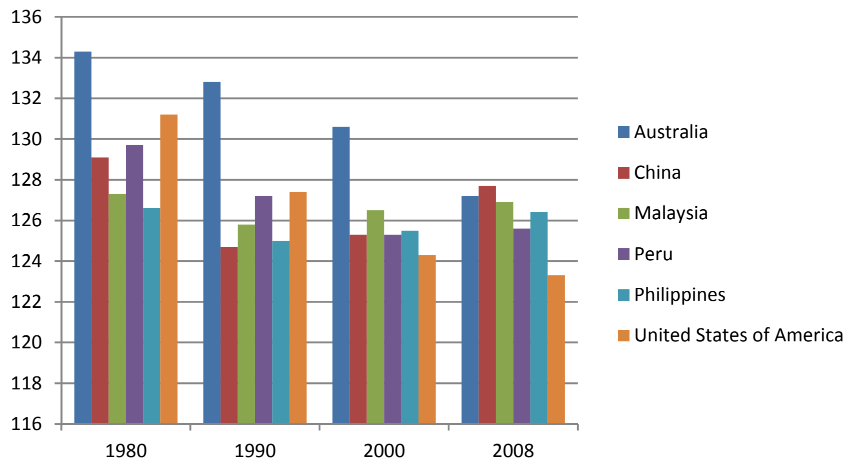


Source: Ng et al. (2014).

Systolic blood pressure

High blood pressure or hypertension is an important risk factor for various forms of cardiovascular disease. High blood pressure can be treated by various forms of medication, and the levels reported in the studies are normally actual blood pressure after the effects of any treatment. Figure 10 shows that age-standardised mean systolic blood pressure (SBP in mm Hg) for males was higher in Australia and the USA than the other countries in 1980, but has fallen considerably and successively in each year since then. Much of this fall is likely to be from the effect of treatment rather than from improvement in the underlying cardiovascular condition.

Figure 10 Mean systolic blood pressure rates, males, six APEC economies, 1980 to 2008



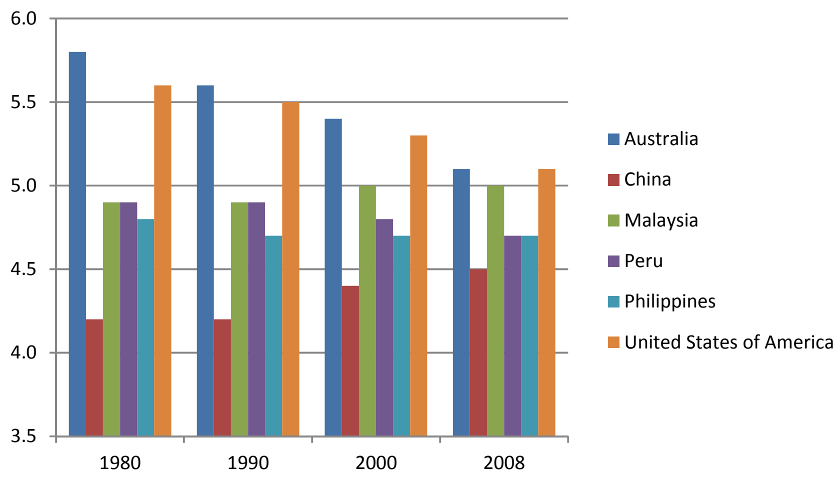
Source:Danaei et al. (2011a).

However, in the three Asian developing economies, blood pressure levels have increased since 1990, after falling between 1980 and 1990. This increase is especially notable for China, where official data suggests that the increase has continued after 2008, but is also substantial for both Malaysia and the Philippines. Peru is again a special case, with mean blood pressure levels falling significantly between 1980 and 2000, albeit rising slightly between 2000 and 2008.

Cholesterol

As with high blood pressure, serum total cholesterol (TC, reported in Figure 11 in mmol/L) is another risk factor for cardiovascular disease. TC rates for males were very high in the 1980s in Australia and the USA, but have fallen significantly since then, presumably in good part as a result of widespread treatment regimes. Trends in the other economies have been mixed. Peru and the Philippines had low TC in 1980 and levels have fallen somewhat since then. In China and Malaysia, TC has risen significantly although levels are still below those in Australia and the USA.

Figure 11 Mean total cholesterol rates, males, six APEC economies, 1980 to 2008



Source: Farzadfar et al. (2011).

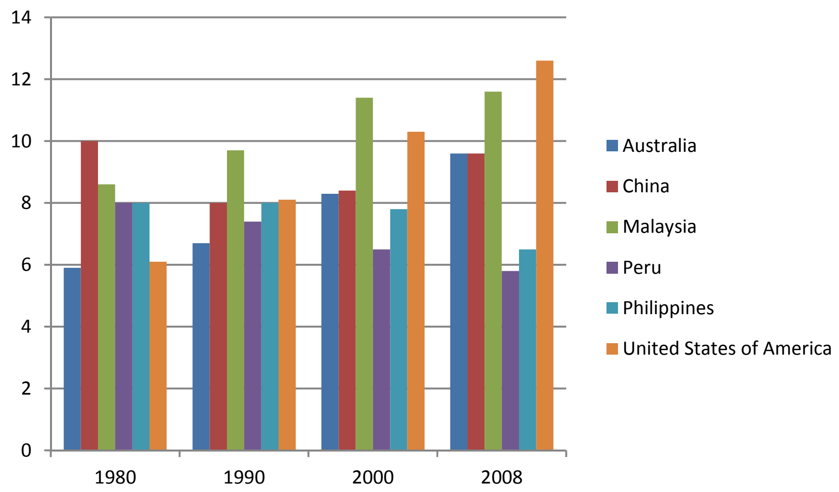
Diabetes

Diabetes is both a disease in itself and an important risk factor for many other NCDs. Largely in contrast to these other risk factors, the prevalence of diabetes among males has increased strongly in Australia and the USA. Malaysia also has high and rising prevalence, significantly higher than Australia, and by 2008 China had reached the same level as Australia. By contrast diabetes prevalence rates in Peru and the Philippines have been falling and are now much lower than in the other economies.

As with hypertension, the measure of diabetes prevalence normally includes diabetes which is treated and controlled, as well as that which is not diagnosed or, if diagnosed, is not controlled by appropriate treatment. In Australia and the USA, a substantial proportion of the diagnosed level of diabetes is controlled, but it is known that, in economies such China, only a modest proportion of actual diabetes is diagnosed and only part of that is controlled. While the movements against the trend in Peru and the

Philippines are striking, the continuing rise in diabetes in the other four economies remains of concern, especially in economies in which control rates are low.

Figure 12 Diabetes prevalence, males, per cent of population, six APEC economies, 1980 to 2008



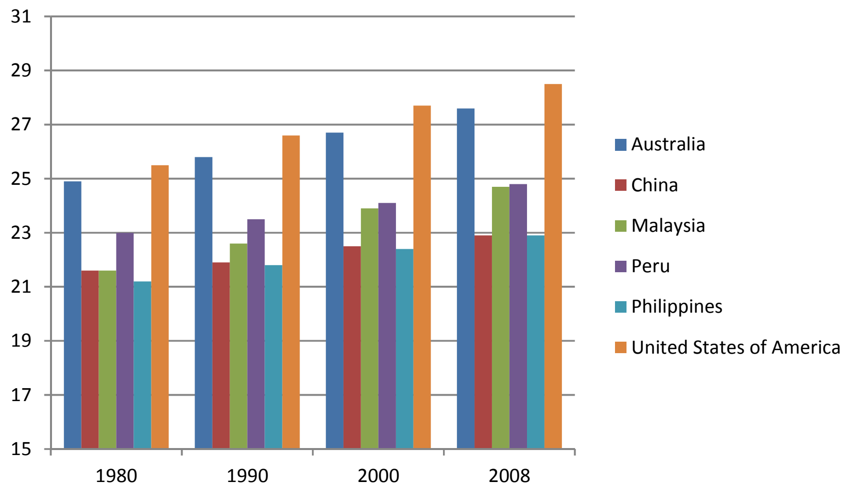
Source: Danaei et al. (2011b).

Body mass index

The final risk factor is overweight and obesity, which is an important risk factor for many NCDs. The widely used measure is the body mass index (BMI), which is defined as a person's weight in kilograms dividied by the square of height in metres. Overweight is defined as values greater than 25 kg/m^2 while obesity is defined as greater than 30 kg/m^2.

BMI for males has increased in all six countries, but notably in Australia and the USA. Levels in 2008 indicate that the average person in those countries is overweight. Mean BMI levels in the developed economies are lower, but also rising. The increase in Malaysia and Peru has brought those countries close to the overweight level on average, with this rise in Malaysia being more rapid than in Peru. While the increases in China and the Philippines have been more modest, they have been steady across the full period and there are signs that the increase has continued beyond 2008.

Figure 13 Mean BMI, males, kg/m², six APEC economies, 1980 to 2008



Source: Finucane et al. (2011).

Conclusions on risk factors and mortality/prevalence assumptions

The foregoing analysis, limited though it is by the availability of data, leads to several tentative conclusions related to our projection assumptions for this study. First, age standardised mortality rates from NCDs have been declining in most of the economies studied, both over the 1990-2010 period and over 2004-12. The only exception to this is the Philippines. But the rate of decline has been modest, with an unweighted average of less than 1% per annum across the six economies. Secondly, the levels of non-fatal, age standardised NCD prevalence implied by the burden of disease YLD data have been remarkably stable over the two decades from 1990-2020, perhaps because of both higher survival rates and a deterioration in lifestyle quality and in risk factors. Thirdly, some of the most important risk factors – such as blood pressure, cholesterol levels, diabetes and BMI – are high and/or rising in most of these economies, and smoking rates remain undesirably high. The main exception from these risk factor generalisations is Peru.

On the basis of these conclusions, the key assumptions that we use in the detailed empirical analysis is that age standardised NCD mortality rates fall for all countries by 1% per annum over the period 2010-30, and that age-standardised NCD non-fatal prevalence rates remain stable for all countries over 2010-30 at their 2010 levels. These assumptions are broadly consistent with the historical record as reviewed above, and could even be viewed as somewhat optimistic given the risk factor trends. A more complex analysis than is possible here would take account of many relevant forms of variation: across economies, by gender and by disease.

Estimating the Worker Attendance and Productivity Costs of NCDs

Modelling methodology

As discussed above, the International Labour Office (ILO 2014) has produced projections of the labour force and labour force participation rates by age and sex for each country to the year 2030, based on UN projections of population. For the modelling of the economic impact of mortality and morbidity, these population and labour force projections were used as the starting point for projections of mortality and morbidity for the years 2010, 2015, 2020, 2025 and 2030 for the six APEC economies.

The modelling of the impact of NCDs is undertaken only for those 13 non-communicable diseases listed in Table 2 that were identified as most relevant to reductions in labour force participation and productivity using the disease descriptions from the 2010 Global Burden of Disease study (Murray et al. 2012).

Table 2 Disability weights and absenteeism and presenteeism assumptions, six APEC economies

Disease	Disability weight	Percent productivity loss due to absenteeism per employee per year	Percent productivity loss due to presenteeism per employee per year
Ischemic heart disease	0.13013	2.8	6.8
Ischemic stroke	0.30300	2.8	6.8
Hemorrhagic and other non-ischemic stroke	0.30300	2.8	6.8
Diabetes mellitus	0.09463	0.8	11.4
Chronic obstructive pulmonary disease	0.19667	6.1	17.2
Asthma	0.05600	5.0	11.0
Migraine	0.43300	4.5	20.5
Tension-type headache	0.04000	4.5	20.5
Major depressive disorder	0.23000	10.7	15.3
Dysthymia	0.11000	10.7	15.3
Osteoarthritis	0.09100	2.5	11.2
Rheumatoid arthritis	0.33733	2.5	11.2
Neoplasm	0.32150	7.0	8.5

Source: Murray et al. (2012), Salomon et al. (2012) and Goetzel et al. (2004).

The number of deaths by age and sex and the number of years of life years lived with disability (YLDs) for 2010 for each of these diseases and for each economy were obtained from the country estimates on the 2010 Global Burden of Disease website.[1] For each of the six economies, the numbers of deaths by age and sex and disease for subsequent years were obtained by multiplying the population estimates by age and sex from the ILO for that year by the projected mortality rate for that age, sex and year. The central case reported below is mortality rates derived by assuming a uniform 1% per annum fall from

[1] At http://ghdx.healthdata.org/global-burden-disease-study-2010-gbd-2010-data-downloads

2010-30, but results are also reported with fixed mortality rates. The total number of deaths in any year from a particular disease was then obtained by summing across the age groups.

To estimate the number of deaths of people in the labour force, the projections by age and sex and disease for a particular year were multiplied by the relevant labour force participation rate for the age and sex category for that year for those aged 15 and over.

The projections of YLDs for the years 2015, 2020, 2025 and 2030 were obtained in a similar manner, by starting from the actual numbers of YLDs by age and sex and disease for 2010 and assuming fixed YLD rates by age, sex and disease out to 2030, so that the projected numbers of YLDs grew in line with the increase in population for the corresponding age and sex group.

Prevalence estimates were obtained from these YLD projections by dividing by the appropriate disability weights obtained from Salomon et al. (2012) and Murray et al. (2012). These weights are shown in Table 2 above. Prevalence estimates for those in the labour force were obtained in the same way as for deaths.

The result of these calculations was a table for each country showing the estimated number of deaths in the labour force for the years 2010 to 2030 for each of the 13 conditions. A similar table was obtained for prevalence estimates.

To estimate the economic impact of this burden of disease, estimates of the value of GDP in current USD were obtained from the World Bank for each of the six economies for 2010. These were divided by the size of the labour force in 2010 to calculate GDP per person in the labour force for 2010. For Australia and the USA, it was assumed that this productivity would increase by 1% per year, and for the other countries by 3% per year, over 2010-30.

To estimate the loss in economic output resulting from the projected deaths, it is assumed that all the deaths in the labour force are averted. That means that the increase in the labour force will be cumulative so that in a particular year it will consist of the deaths averted in that year plus those averted in previous years. For instance in Australia, there will be 20,885 deaths averted in the labour force rising to a cumulative total in 2030 of 61,414 deaths averted. Multiplying these estimates of the additional numbers in the labour force in a particular year by the assumed productivity gives estimates of the additional GDP generated in each year because of these deaths averted.

To calculate the economic loss due to morbidity suffered by people in the labour force, it is necessary to quantify what impact disease has on labour force participation and on productivity at work. For this we use the estimates by Goetzel et al. (2004) on productivity loss due to absenteeism and presenteeism by disease fitted to the disease categories used in the modelling (Table 2). An extensive review of the literature in the various countries on these issues has been conducted for this project, some highlights of which are provided in the Appendix to this report, but no better source of such estimates has yet been identified.

Multiplying the GDP per person in the labour force estimates by the loss in productivity from a disease gives the estimated reduction in GDP per person attributable to a particluar disease. Multiplying this by the prevalence in the labour force of that disease gives an estimate of the annual loss in GDP from that disease.

Summary estimates

The deaths averted in the labour force and the increase in GDP this represents, are shown in Tables 3 to 6. The projections of deaths averted are made under two scenarios. One assumes that death rates will remain constant as shown in Figure 8, while the other assumes that death rates will decline at 1% per annum. Given that the assumed intervention is to avert all future NCD deaths, the first scenario will result in higher levels of projected deaths *averted* than the second. This results in the increase in the labour force being greater under the first scenario than the second, as shown in Tables 3 and 4 respectively. This means that the increase in GDP arising from the deaths saved will be higher for the first scenario (constant mortality rates) (Table 5) than the second (declining death rates at 1% per annum) (Table 6).

Table 3 Labour force increase due to deaths averted, 2010 to 2030, at constant mortality rates (persons)

Year	Australia	China	Malaysia	Peru	Philippines	USA
2010	20,885	2,125,681	23,098	32,453	115,962	462,360
2015	34,013	3,482,756	39,551	49,177	205,212	715,829
2020	44,854	4,709,685	55,071	65,775	292,456	911,682
2025	54,429	5,722,876	70,258	82,617	371,888	1,059,565
2030	61,414	6,351,262	82,251	94,891	420,797	1,133,138

Source: VISES estimates.

Table 4 Labour force increase due to deaths averted, reduced death rates 2010 to 2030 (persons)

Year	Australia	China	Malaysia	Peru	Philippines	USA
2010	20,885	2,125,681	23,098	32,453	115,962	462,360
2015	32,346	3,312,066	37,612	46,767	195,154	680,746
2020	40,565	4,259,355	49,805	59,486	264,492	824,508
2025	46,812	4,922,007	60,426	71,055	319,845	911,288
2030	50,231	5,194,741	67,273	77,612	344,173	926,801

Source: VISES estimates.

The two labour force tables show that the cumulative increase in the labour force if all NCD deaths were averted is substantial. On the constant mortality assumption, the labour force gains range from 61,000 in Australia, to over 1.1 million in the USA and over 6.3 million in China. On the assumption of 1% per annum reduction in death rates, the numbers are somewhat smaller, ranging from 50,000 in Australia to 927,000 in the USA and just on 5.2 million in China.

Tables 5 and 6 show the conversion of these labour force increases into increased GDP, using economy-specific estimates of GDP per employee. The figures rise sharply over time, as lives saved build cumulatively and the potential increment to GDP rises. Even on the reducing mortality rate basis, the GDP figures are large, and rising rapidly in the developing countries, reaching $87 billion per annum in the USA and $70 billion per annum in China by 2030, with corresponding figures for the smaller economies covered.

Table 5 Increase in annual GDP due to increase in labour force, constant mortality rates to 2030 (US$ billion)

Year	Australia	China	Malaysia	Peru	Philippines	USA
2010	2.00	16.02	0.47	0.31	0.59	43.50
2015	3.43	30.43	0.99	0.54	1.21	70.78
2020	4.75	47.70	1.67	0.84	2.00	94.74
2025	6.06	67.19	2.59	1.23	2.96	115.73
2030	7.19	86.44	3.69	1.64	3.88	130.08

Source: VISES estimates.

Table 6 Increase in annual GDP due to increase in labour force, reduced death rates 2010 to 2030 (US$ billion)

Year	Australia	China	Malaysia	Peru	Philippines	USA
2010	2.00	16.02	0.47	0.31	0.59	43.50
2015	3.26	28.93	0.94	0.52	1.15	64.01
2020	4.30	43.14	1.51	0.76	1.81	77.49
2025	5.21	57.79	2.23	1.06	2.54	85.60
2030	5.88	70.70	3.02	1.34	3.17	87.02

Source: VISES estimates.

The estimated reductions in GDP due to the impact of the ongoing non-fatal prevalence of the 13 diseases on labour force particpation and productivity are shown in Table 7. It is immediately evident that the prevalence costs, through both absenteeism and presenteeism, are an order of magnitude higher than the mortality costs, although the later rise faster over time. For example, the prevalence costs reach $308 billion (1.5% of GDP) for absenteeism and $748 billion (3.6% of GDP) for the USA by 2030, and $113 billion (1.0% of GDP) and $302 billion (2.7% of GDP) for the two forms respectively for China by that year.

For many of the chronic diseases listed in Table 2 and covered by the analysis ongoing morbidity is more important, and more disruptive of effective labour force involvement, than the threat of imminent death. Examples include pulmonary disease, migrane headaches, depression and rheumatoid arthritis. As a result a much larger number of people suffer from a chronic disease each year than die from one. Hence even the number of deaths from NCDs are cumulative in their labour force impact over time, the labour force costs from absenteeism and presenteeism are a substantial mutiple of those from deaths, for each country.

Table 7 Increase in GDP due to reduction in absenteeism and presenteeism, six APEC economies

Country	Year	Total reduction in GDP USD million Absenteeism	As % GDP	Total reduction in GDP USD million Presenteeism	As % GDP
Australia	2010	14,551.5	1.27	35,334.8	3.09
	2015	16,281.2	1.28	39,686.9	3.13
	2020	18,189.4	1.30	44,481.8	3.17
	2025	20,336.9	1.31	49,856.7	3.20
	2030	22,793.6	1.31	55,984.2	3.23
China	2010	54,595.6	0.92	138,897.1	2.34
	2015	67,562.7	0.94	174,183.7	2.43
	2020	81,088.5	0.97	211,954.4	2.53
	2025	96,582.5	1.00	255,841.7	2.64
	2030	112,845.4	1.01	302,152.8	2.70
Malaysia	2010	3,398.5	1.37	7,651.1	3.09
	2015	4,733.7	1.39	10,703.5	3.14
	2020	6,419.6	1.41	14,611.1	3.21
	2025	8,550.4	1.44	19,631.8	3.30
	2030	11,236.4	1.47	26,067.7	3.41
Peru	2010	2,125.9	1.43	4,882.7	3.29
	2015	2,738.9	1.44	6,332.7	3.34
	2020	3,502.2	1.46	8,157.7	3.40
	2025	4,432.4	1.47	10,407.1	3.46
	2030	5,552.1	1.49	13,144.4	3.53
Philippines	2010	2,979.9	1.49	7,015.6	3.52
	2015	3,927.9	1.50	9,282.4	3.55
	2020	5,097.4	1.51	12,092.1	3.59
	2025	6,564.9	1.52	15,638.8	3.63
	2030	8,370.5	1.54	20,037.9	3.68
USA	2010	216,339.8	1.45	520,081.7	3.48
	2015	236,682.9	1.46	571,539.7	3.52
	2020	258,793.5	1.46	626,719.7	3.55
	2025	281,852.7	1.47	684,044.2	3.58
	2030	307,554.9	1.48	748,067.3	3.60

Source: VISES estimates.

Interpreting the estimates

The overall estimates of the GDP losses arising from deaths (from 2010 onwards) and from absenteeism and presenteeism from the prevalence of NCDs in the actual and potential workforce are summarised in Table 8 and in Figure 14. Table 8 shows the total estimated losses in US$ billions, at 2010 values, at five year intervals over 2010-30, and also these costs as a share of GDP for each economy. Figure 14 expresses the total real value of the losses at an index, with 2010 set equal to 100, and hence shows the growth in costs in each economy from the 2010 base.

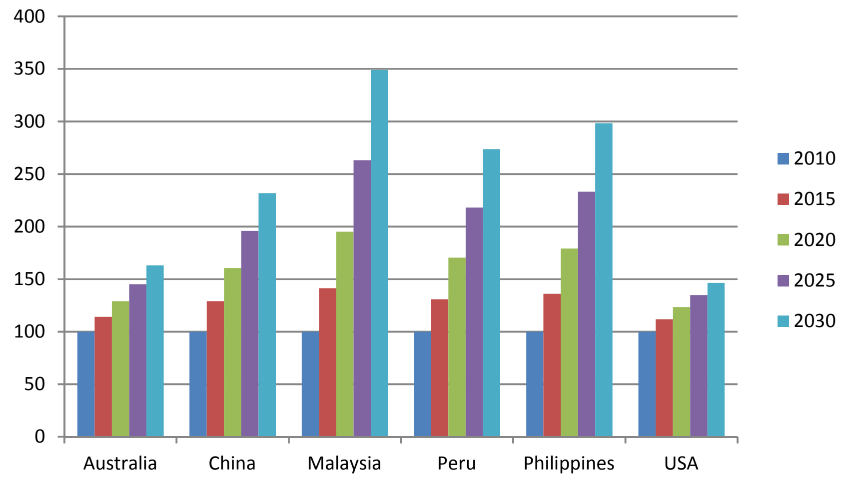
In interpreting these estimates, it is important to note that they primarily reflect the pattern of ageing of the population of labour force age in the various economies and the level of age standardised NCD mortality and non-fatal prevalence rates in 2010. In countries such as the USA where ageing is well advanced and 2010 mortality and prevalence rates are relatively high, the cost by 2010 is already relatively high and the future growth in cost more limited. This in part reflects the fact that many of the costs of the interaction of ageing and NCDs are felt beyond the years of labour force age.

Table 8 Estimates of lost GDP from NCD deaths, absenteeism and presenteeism, six APEC economies, to 2030

	2010	2015	2020	2025	2030
			($billion)		
Australia	51.9	59.3	67.0	75.4	84.7
China	209.5	270.6	336.1	410.2	485.7
Malaysia	11.5	16.3	22.5	30.4	40.3
Peru	7.3	9.6	12.5	15.9	20.0
Philippines	10.6	14.4	19.0	24.7	31.6
USA	779.9	872.2	963.0	1051.5	1142.6
			(share of GDP – %)		
Australia	4.5	4.7	4.8	4.8	4.9
China	3.5	3.8	4.0	4.2	4.3
Malaysia	4.6	4.7	4.9	5.0	6.1
Peru	4.9	5.1	5.2	5.3	5.4
Philippines	5.3	5.5	5.6	5.7	5.8
USA	5.2	5.4	5.5	5.5	5.5

Source: VISES estimates.

Figure 14 Indexes of the estimated real GDP lost from NCD deaths and non-fatal prevalence, six APEC economies, (indexes 2010=100)



Source: VISES estimates.

A number of factors seem particularly pertinent in interpreting the estimates summarised in Table 8 and Figure 14. The figure in particular brings out that the growth in real costs over 2010-30 is particularly pronounced for the four developing economies. In analysing the impact of population on the age structure of the labour force, we noted above (see Figure 5) that the share of the labour force aged 45 years and over rose particularly sharply in China, Malaysia and Peru over 2010-30. Age standardised mortality rates from NCDs in 2010 were significantly higher in China, Malaysia and the Philippines than in the other economies, while only China had a notably low NCD YLD rate in 2010. These factors go a long way to explaining the pattern of costs shown in Table 8 and Figure 8, especially given that no economy-specific assumptions changes in NCD mortality or prevalence rates after 2010 have been made. Such an analysis would be appropriate for further study, if adequate data can be identified.

The rapid growth in costs in Malaysia, Peru and the Philippines is also influenced by the more rapid growth in the population and in the labour force in these economies. Over 2010-30 the total labour force is projected to grow by 1.7% per annum in Malaysia and Peru, and by 2.1% in the Philippines. By contrast China's labour force is projected to grow by only 0.2% over this period, and indeed to peak in 2020.

Estimates and the Broader Cost Picture

Substantial as they are, it is crucial to note that these estimates are only a part of the full economic and social costs arising from NCDs, and even of the economic costs in the narrow sense of costs likely to be reflected in GDP as currently measured (see Table 1 above). The main economic costs excluded are the costs of treating and caring for those with NCDs of the type we are discussing here. Not only do these treatment costs need to be met by firms, individuals and governments, but some of the resources required will be diverted from savings, reducing the level of investment and hence the future growth capacity of the firm or the economy. Some have argued that these dynamic costs are the most important of all the economic costs, and they have not been considered here.

For example, Bloom et al. (2013) modelled the costs of NCDs for China and India in a closed Solow model consisting of only firms and households in two ways, with two key effects:

1. Productive capital is reduced by a reduction in savings to the extent that savings are diverted to finance increased health costs. This reflects the effect on the incentives for savings and investment in both physical and human capital due to complex interactions between the costs of earlier retirement imposed on firms, finding replacement workers, training costs and lower life expectancy leading to lower savings.
2. Labour supply is reduced by age specific mortality so a higher death rate from NCDs is associated with a higher reduction of workers in a particular cohort.

Their model does not attempt to incorporate morbidity, or more subtle effects on labour supply and productivity through absenteeism or presenteeism, which is a central element of our analysis (and the major source of costs).

These authors find that the economic costs of NCDs to China, in undiscounted constant US$, amount to some $11 trillion over the 20-year period, with most of this effect coming from the savings and investment effect. This compares with our estimate, which totals about $7 trillion for China from the mortality and absenteeism/presenteeism alone. Thus Bloom et al. (2013) find that for China the savings and investment effects are very large.

Other papers (such as de Vol et al. 2007) which have adopted a production function approach to measure the impact of NCDs on the growth of GDP, especially through the impact on investment and the growth of the capital stock, have found that the costs of NCDs through these effects are very large. But these methods are theoretically complex and data intensive, and have not been attempted in this project. It should be noted, however, that the narrowly economic costs that are thereby excluded from this study may well be of a similar order of magnitude again to those that are identified here.

Appendix: Evidence from Countries

Australia

This section provides an overview of a number of studies of the economic impact of a range of diseases in Australia. Most of these studies estimate the cost to the economy in lost output due to workers or potential workers suffering from the disease. Some studies extend the analysis to also include estimates of the cost to carers, the government and some include estimates of the social cost by valuing premature mortality and morbidity associated with the disease. Other studies are economy-wide analyses looking at the overall cost of the burden of disease in general or in terms of its impact on workplace participation and productivity.

In a range of studies, Access Economics has estimated the economic costs of specific conditions. They have found for instance that:

- in 2012 the financial cost of **stroke** was $5.0 billion of which $3.0 billion represented lost productivity while the social cost was $49.3 billion so the financial and social costs of stroke are estimated to be around 0.3% and 3.3% of GDP respectively;
- the financial cost of **chronic obstructive pulmonary disease** (COPD) was $8.8 billion in 2008, of which $6.8 billion (76.6%) was productivity lost due to lower employment, absenteeism and premature death. The social cost (due to disability and premature death) was estimated to be a further $89.4 billion; and
- for **heart attacks (acute myocardial infarction)** and **chest pain (angina)** lost productivity was $2.6 billion in 2009, with $2.28 billion in productivity losses from **vision loss** and $10.6 billion from **mental illness in people aged 12-25.**

In a recent analysis for beyondblue, PricewaterhouseCoopers (PWC 2014) estimated the return on investment for creating a mentally healthy workplace by estimating the cost to employers of **mental health condition**s and the cost of a range of workplace programs. They found that through the successful implementation of an effective action to create a mentally healthy workplace, organisations, on average, can expect a positive return on investment (ROI) of 2.3.

Deborah Schofield and her colleagues at the University of Sydney and NATSEM have estimated costs of early retirement due to disease among individuals aged 45 to 64.

- There was a loss of $18.0 billion per annum because of **ill health** in 2009.
- There was a loss of $1,324 million in GDP in 2010 due to **type 2 diabetes** in 2009.
- A loss of $9.4 billion from early retirement due to **arthritis in 2009**.
- A loss of $748 million in lost GDP from **cardiovascular disease.**
- A loss of $1.1 billion in 2009 from **depression** and $1.5 billion from **other mental conditions.**

In a study for Medibank Private in 2011, KPMG Econtech found that:

- In 2009-10, the total cost of presenteeism to the economy was estimated to be 2.7 per cent of GDP or the equivalent of $34.1 billion in 2008-09 prices.

The largest contributors to overall productivity loss from presenteeism were the following.

Table A1 Disease and loss of productivity, Australia, 2009-10

Disease/condition	%
Allergy	17
Any cancer	4
Arthritis	4
Asthma	7
Back, neck, spinal problems	7
Depression	21
Diabetes	12
Eczema, other skin conditions	3
Heart disease	4
Hypertension	13
Migraine/headache	5
Respiratory disorders	3

Source: KPMG Econtech (2011).

United States

This section provides an overview of a number of studies of the economic impact of a range of diseases in the USA. Most of these studies estimate the cost to the economy in lost output due to workers or potential workers suffering from the disease. Some studies extend the analysis to also include estimates of the cost to carers, the government and some include estimates of the social cost by valuing premature mortality and morbidity associated with the disease. Other studies are economy-wide analyses looking at the overall cost of the burden of disease in general or in terms its impact of workplace participation and productivity.

DeVol et al. (2007) estimated the costs arising from seven common diseases – **cancer, diabetes, hypertension, stroke, heart disease, pulmonary conditions** and **mental disorders** for the USA in 2003. They found that the total cost to the economy was $1,342 billion comprising $277 billion in treatment costs and $1,047 billion in lost economic output. Of the latter, presenteeism accounted for $908.4 billion, and lost workdays $138.3 billion.

Updating this to the period 2008-2010, Chatterje et al. (2014) estimated that for five of these conditions (cancer, diabetes, heart disease, hypertension and stroke), the treatment costs would be $276.2 billion and the costs from lost output would be $1,226 billion.

Davis et al. (2005) in a study on health and productivity among US workers found that in 2003, labour time lost due to health reasons represented lost economic output totalling $260 billion per year. Of this, non-working adults reporting disability, handicap, or chronic disease or non-working because of health reasons accounted for $185 billion, workers with any sick days $48 billion and workers with reduced productivity days $27 billion.

Heidenreich et al. (2011) estimated the future costs of care for **cardiovascular diseas**e including hypertension, coronary heart disease, heart failure, stroke, and all other CVD from 2010 to 2030 in the USA. They found that total direct medical costs of CVD are projected to triple, from $273 billion to $818 billion and real indirect costs (due to lost productivity) for all CVD are estimated to increase from $172 billion in 2010 to $276 billion in 2030, an increase of 61%.

The American Academy of Orthopaedic Surgeons (AAOS 2011) in its report on the economic cost of **musculoskeletal disease** in the United States estimated that for the years 2004-2006, the annual average direct cost, in 2006 dollars, for musculoskeletal health care, both as a direct result of a musculoskeletal disease and for patients with a musculoskeletal disease in addition to other health issues, is estimated to be $576 billion, the equivalent of 4.5% of the national gross domestic product (GDP). Indirect cost, expressed primarily as wage losses for persons aged 18 to 64 with a work history, adds another $373.1 billion, or 2.9% of the GDP in 2004-2006. Taking into account all costs for persons with a musculoskeletal disease, including other comorbid conditions, the cost of treating these individuals in addition to the cost to society in the form of decreased wages is estimated to be nearly $950 billion per year, 7.4% of the 2006 GDP.

In a study in 2002 at 5 locations within the Dow Chemical Company on the prevalence and costs for chronic health conditions, Collins et al. (2005) found the average costs per employee in 2002 dollars were $2278 for medical care, $661 from absenteeism and $6721 from work impairment or presenteeism. This represented 10.1% of total labour cost at Dow in 2002, 6.8% from presenteeism, 2.3% from medical care and 1.0% from absenteeism.

Goetzel et al. (2004) compiled evidence about the total cost of health, absence, short-term disability, and productivity losses for 10 health conditions in the USA from a large medical/absence database and several published productivity surveys. They found that depression had the highest rates of absent days per year followed by cancer and respiratory disorders. Depression, headaches and respiratory disorders were major factors in presenteeism.

According to the US Agency for Healthcare Research and Quality (2014), the total expenditure in the USA in 2011 for selected conditions was as shown in Table A2.

Table A2 Expenditure for selected conditions, United States, 2011

Condition	Total expenditure, USD billion	Mean expenditure per person receiving care, USD
Heart conditions	116.3	4,886
Cancer	88.7	5,537
Mental disorders	77.6	1,803
Osteoarthritis and other non-traumatic joint disorders	76.2	2,024
COPD, asthma	75.2	1,604
Diabetes mellitus	55.2	2,317
Hypertension	42.7	707
Hyperlipidemia	38.9	812
Back problems	38.1	1,878
Cerebrovascular disease	17.5	4,692
Other bone and musculoskeletal disease	13.7	1,855
Headache	8.4	997

Source: Agency for Healthcare and Research Quality (2014).

China

For China, of the studies found in an extensive search of the literature on the economic impact of poor health, and on productivity in particular, a paper by Bloom et al. (2013) was the most the most relevant. It uses an augmented Solow model which assumes that national income depends on capital stock, the labour force size, and aggregate measures of human capital to measure the economic impact of NCDs in China and India. The advantages of this approach over the cost of illness studies is that it provides a more complete picture of the true macroeconomic impact of disease. In particular, it has the capacity to incorporate the impact of health on capital accumulation, investment in human capital and demographic change.

Bloom et al. (2013) notes several pathways for the impact of NCDs on GDP:

- increase in health expenditures reducing consumption by households and reduce income for firms through increased social insurance premiums;
- reduction in labour supply due to increased mortality and reduced productivity of the sick;
- indirect productivity impacts include reduced cognitive abilities and increased absenteeism; and
- effect on the incentives for savings and investment in both physical and human capital due to complex interaction between the costs of earlier retirement imposed on firms, finding replacement workers, training costs and lower life expectancy leading to lower savings.

In modelling these effects, Bloom et al. (2013) augment a closed Solow model consisting of only firms and households in two ways. It is assumed that:

1. Productive capital will be reduced by a reduction in savings to the extent that savings are diverted to finance increased health costs.

2. Labour supply is reduced by age specific mortality so a higher prevalence is associated with a higher reduction of workers in a particular cohort.

The model does not attempt to incorporate morbidity, or more subtle effects on labour supply and productivity through absenteeism or presenteeism. Nor does it seek to model the more complex interactions between households and firms that will lead to impacts on human capital.

The results of the modelling focus on five NCD-specific disease categories, which are then scaled up to match the four disease conditions which are the focus of the UN. The results are given in Table A3 below for China as undiscounted but constant dollar amounts for the period 2012-2030.

Table A3 Losses from disease, China, 2012-2030

Disease	Loss, 2010 USD (trillions)
Diabetes	0.49
Ischemic heart disease	1.63
Cerebrovascular disease	4.66
COPD	4.03
Breast cancer	0.19
TOTAL	11.0

Source: Bloom et al. (2013, p. 18).

Once scaled up to account for all the major NCD groups, the economic burden for China is estimated to be 27.8 trillion 2010 USD which the paper compares with China's expenditure on health for the previous 19 years of USD 2.2 trillion. Using 'best buy' interventions could lead to 10-15 per cent reductions in economic costs or about USD 54 billion per year (Bloom et al. 2013, p. 25).

Specific economic impact disease studies for China: Comments on the China literature

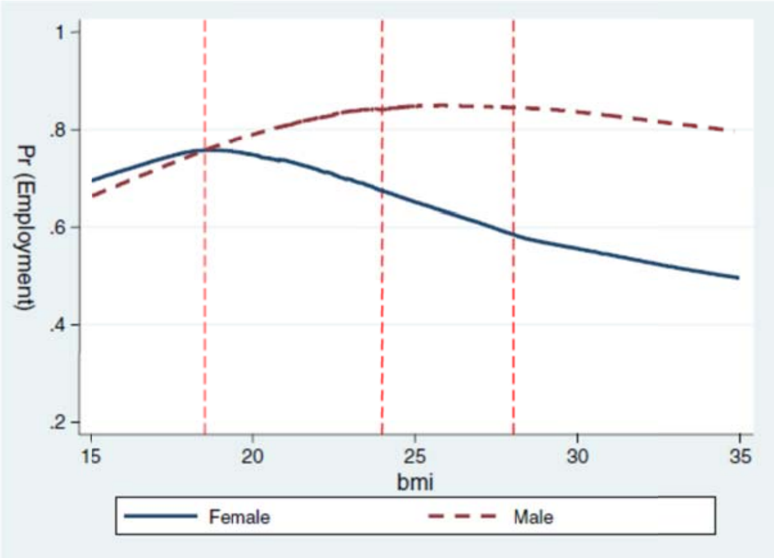
The literature surveyed produced two types of results for specific diseases. Unfortunately none of these dealt with the diseases that are the focus of this study. The first provides estimates of the economic burden of particular disease using the human capital approach (Zhen Hong et al. 2009; Min Hu and Wen Chen 2009; Fang et al. 2011). Some of these were calculated from cost of illness studies and other methodologies that included CGE modelling and Monte Carlo simulation. The second sought to provide evidence of the impact of a particular disease or condition on the ability to work (Lu et al. 2009; Langley et al. 2011). Each methodology found a significant economic impact of the particular disease.

However each of the methodologies had their shortcomings. The cost of illness studies made no attempt to include the dynamic effects suggested by the WHO guide (WHO 2009) and captured in the methodologies of DeVol et al. (2007) and Bloom et al. (2013) on economic growth through capital effects. The burden of disease study (Zhong and Li 1995) did not include the impact morbidity.

This suggests methods are required that incorporate both morbidity and the dynamic effects of the impact of illness through the impact on capital.

The study by Pan et al. (2013) adopted a different approach by establishing the role of a single risk factor body weight/BMI in the probability of employment. This showed that the 'optimal BMI' for employment, shown in the Figure A1 below, was as much a result of the prejudices of employers (especially for females) as the negative health consequences of being overweight.

Figure A1 Optimal BMI for employment



Source: Pan et al. (2013).

The English language literature on the economic impact of disease in China tends to address single conditions using a range of methodologies. A number of these studies are discussed in Table A4 below.

Table A4 Studies on impact of disease, China

Authors	Disease/ Condition	Type of study	Nature of study	Results
Fang et al. (2011)	Influenza pandemic	Monte Carlo simulation		Work days lost based on estimates from expert from 30 hospitals.
Langley et al. (2011)	Rheumatoid arthritis (RA)	GLS modeling Internet based urban China National health and Wellness Survey	353 self-reported rheumatoid arthritis from survey of 13,307 persons aged 18 and over	GLS modeling with a range of SES and behavioural risk factors as control variables showed RA to have significant impact of absenteeism and presenteeism.
Lu et al. (2009)	Mental health	Instrument Variable estimation approach to establish causation between mental health and employment status and income	5053 persons from China Health Surveillance Baseline Survey conducted in 9 provinces selected to incorporate coastal , mid and western regions covering 5400 households and 18460 individuals	Reduced probability of employment (85.1% vs 61.4% male and 78.7% vs 41.1 female) and income arising from self-reported mental health, good vs poor.
Min Hu and Wen Chen (2009)	Chronic hepatitis B	Cost of illness study Based on structured household questionnaire	699 persons from Beijing and Guangzhou asked to provide SES and recall various medical cost data including sick leave	Indirect human capital costs based on sick days and other days lost by patient and family times average daily income.

Pan et al. (2013)	Body size and BMI	Instrument variable estimation approach to establish causation between body size, BMI and probability of being employed	Sample of 60017 observations (26471 individual respondents) based on Urban Resident Basic Medical Insurance (URBMI) survey conducted by Peking University Guanghua School of Management	BMI plays significant role in probability of employment – relationship inverted U shape and more negative for females above optimal BMI. While health factors have important role body size discrimination also based on 'employers subjective prejudice' (p. 259).
Yang et al. 2013	Labour supply and pollution	Dynamic fixed effects panel data model with autoregressive distributed lags	Annual data for 30 Chinese provinces 1991 to 2010	Based on proposition that labour supply will decrease with pollution due to reduced utility of income (income effect) and labour supply positively rated to pollution due to reduction in utility of leisure (subst. effect). Proposition of relation between pollution and labour implies direct relation b/w work place and experience of pollution. Find that relation between pollution and wage rate is inverted U shape.
Zhen Hong et al. (2009)	Epilepsy	Cost of illness based on patients treated at West China Hospital, Sichuan	289 participants, Sichuan Indirect costs estimated from working days lost Unemployment, sick leave and early retirement	Costs per patient: - Direct medical RMB 2529 - Direct non-medical RMB 756 - Indirect costs RMB 1968
Zhong and Li (1995)	Pneumoconiosis (silicosis, asbestosis, coal workers)	PYLL PYWL (work lost) using a 'measurement index' based on a proportionate mortality ratio Based on Nationwide Epidemiological Study of Pneumoconiosis patients	393,797 pneumoconiosis patients 79,636 deaths of which 74,224 were selected for study	PYLL based on age 75 av. 19.9. PYWL based on 1-35 years of employment av. 19.7.

Malaysia

There are a few studies for Malaysia on the effect of disease on worker attendance. A 1995 study by Indran et al. attempted to determine the prevalence of sickness absenteeism among the three types of agencies, government, semi-government (boards) and private (public) companies. Using retrospective data via questionnaires on medical leave over the year 1990, they calculated the indices of absenteeism. Their findings showed that:

> …private agencies scored higher for all the indices but only the "lost time" percentage was significantly increased. Females also had significantly higher severity of sickness absenteeism rates in all the agencies.

> Overtime work was associated with higher absenteeism indices, markedly noted in the private agencies. (p. 9)

Saroja et al. (1999) conducted a study to determine the relationship between absenteeism rates and psychological intervention in an organization with 334 employees in Klang Valley in Malaysia with high rates of absenteeism. The rates were measured every 6 months between January 1991 and December 1992 (4 periods). All those identified with one count of psychological intervention were given counselling, referred to appropriate agencies and given psychiatric treatment. They found that 'the percentage of absenteeism rate of less than 7 days was significantly reduced between July and December 1992, as compared to July and December 1991' (p. 349); for longer periods of absenteeism, the rates were higher, which they attributed to more serious illness.

Lai et al. (2006) investigated the economic burden of asthma in eight countries in the Asia Pacific including Malaysia. Annual per patient direct cost for Malaysia was US$108 and societal cost was US$210. Table A5 below shows societal costs for other countries.

Table A5 Total per-patient societal costs of asthma by country, 2006

Country	Subjects (n)	Total societal per-patient cost (US$)	Total societal per-patient cost (percentage of per capita GDP)
China	399	336	39
Hong Kong	402	1189	5
Korea	401	331	3
Malaysia	401	210	5
The Philippines	400	277	28
Singapore	400	450	2
Taiwan	395	495	4
Vietnam	393	184	46
Total	3192	435	16

Source: Lai et al. (2003, pp. 13-14).

Peru

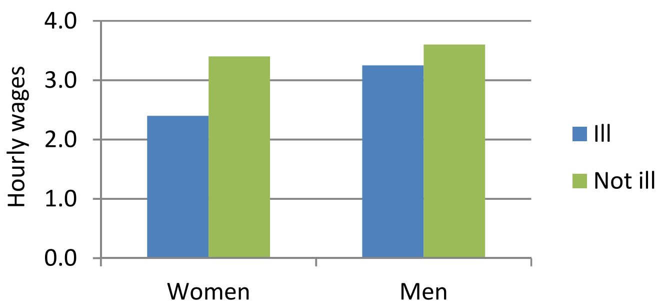
Two studies linking health and work were published in a book edited by Savedoff and Schultz and published by the Inter-American Development Bank in 2000 titled *Wealth from Health: Linking Social Investments to Earnings in Latin America*.

The first study is by Murrugara and Validivia (2000) who analyse the impact of health status on earnings for Peruvian urban adults. They use number of days ill as a health indicator and reduction in wages as the effect on earnings. They conclude that 'health does have a significant impact on productivity as measured by earnings, particularly in the case of urban men', but that also 'effects vary across different sectors, across wage distribution, across public and private employment, by age and by sex' (p. 185). The largest effects are among those at the bottom of the wage distribution with lowest paid workers losing 3.8 per cent hourly wages per day of illness, and the self-employed, losing 4.3 per cent. Private sector workers lose less at 1.8 per cent (p. 151).

The second study by Cortez (2000), 'seeks to measure the effect of health on the hourly wages of adult men and women in the rural and urban areas of Peru' (p. 189). His principal finding is that the number of days sick has a significant positive effect on productivity at work (p. 189). One day less of reported illness increases wages of urban and rural women by 3.4 per cent and 6.2 per cent respectively, and for urban and rural men 4.7 per cent and 14.2 per cent respectively (p. 189).

Cortez also conducted a study of the impact of health services on employment and productivity (2001). He presents the following figure which includes men and women of working ages 16-70 years of age. Illness in women reduced their wages by 26%, whereas in men it only reduced their wages by 10%.

Figure A2 Illness and hourly wages, male and female, II trimester, Peru, 1998



Source: Cortez (2001, Graphico 2, p. 155).

An earlier study was conducted by Luerssen (1993) from April 1987 to July 1988 in the small Peruvian Andean town of Nunoa with a population of 3,500 to 4000. Luerssen collected data from 3 distinct groups: low-income non-farming households, low income agriculturalists, and moderate income households, both farming and non-farming (p. 265). Data was also drawn from a socioeconomic census of 675 households (80% of the population). Table A6 summarizes Luerssen's findings of days of work lost due to illness. Luerssen also found that 'almost half of the households from the poor non-farming group had adult members who suffered from chronic illness which impaired their ability to work for at least three months out of the year' (p. 272).

Table A6 Estimated-persons-days of work lost due to illness per adult household member, Peru, 1988

	Low income non-farming	Low income farming	Moderate income
Days lost per adult member over 6 months			
Mean	48	17	11
Median	21	7	0
Percentage of households losing no days	11	15	53
Days lost per adult member during 4-week recall periods			
Mean	5.1	3.0	1.6
Median	2.7	1.7	0.9
Percentage of households losing no days	12.0	20.0	42.0

Source: Luerssen 1993, p. 270, Table 4.

The Philippines

In the Philippines, Chansarn (2010) details a study which calculates the growth rates of labour productivity in 30 countries during 1981 to 2005, examining the influence of education, health and technological progress on productivity growth. The findings show that 'growth rates of labour productivity of every country, except the Philippines, were greater than four percent per annum during 1981-2005' (p. 249).

A study by Baquilod et al. (2006) linking tobacco to poverty in the Philippines, includes a detailed study of tobacco-related burden of disease (BOD) and health care costs of each of 4 tobacco-linked diseases, lung cancer, chronic obstructive pulmonary disease, coronary artery disease and cerebrovascular disease. These costs include productivity costs – productivity losses from deaths, from disease and total economic costs.

Results on economic costs, which include health care costs and productivity losses from deaths and illnesses from these four smoking-related diseases, range from US$2.86 billion to US$6.05 billion (PhP120 billion to PhP254 billion based on exchange rate of PhP42.00 to US$1.00), depending on the methodology used. Table A7 presents results from Baquilod et al. (2006).

Table A7 Summary of economic costs, US$ attributed to 4 smoking-related diseases, the Philippines, 2003 (US$=PhP 52)

Smoking related diseases	Health care costs	Productivity losses from death	Productivity losses from disease	Total costs
Using SAMMEC methodology				
Lung cancer	9.2	189.7	3.4	202.3
CVD	507.32	2930.5	38.9	3476.8
CAD	236.9	1312.8	88.9	1638.6
COPD	104.6	569.5	54.0	728.1
All 4 diseases	857.9	5002.6	185.3	6045.8
Using Peta Lopez methodology				
Lung cancer	7.8	65.4	2.9	76.1
CVD	287.2	650.9	23.3	961.4
CAD	132.3	1080.9	54.3	1267.5
COPD	74.2	435.9	40.0	550.1
All 4 diseases	501.4	2233.1	120.6	2855.2

Source: Baquilod et al. (2006, p. 125).

References

Agency for Healthcare Research and Quality 2014, 'Medical Expenditure Panel Survey Tables', US Department of Health and Human Services, Rockville, Maryland, at http://meps.ahrq.gov/mepsweb/data_stats/quick_tables_search.jsp?component=1&subcomponent=0

American Academy of Orthopaedic Surgeons (AAOS) 2011, 'Health care utilization and economic cost of musculoskeletal diseases', in AAOS, *The Burden of Musculoskeletal Diseases in the United States*, Rosemont, Illinois, chap. 9, pp. 219-252, at http://www.boneandjointburden.org/chapter_downloads/index.htm

Baquilod, M.M. et al. 2008, *Tobacco and Poverty in the Philippines*, World Health Organization, Geneva.

Bloom, D.E. et al. 2013, 'The Economic Impact of Non-communicable Disease in China and India: Estimates, Projections and Comparisons', NBER Working Paper, No. 19335; PGDA Working Paper No. 107, Program on the Global Demography of Aging, Harvard Center for Population and Development Studies, Cambridge, Massachusetts, at http://www.hsph.harvard.edu/pgda/WorkingPapers/2013/PGDA_WP_107.pdf; and also IZA Discussion Paper, No. 7563, Institute for the Study of Labor, Bonn.

Chansarn, S. 2010, 'Labor Productivity Growth, Education, Health and Technological Progress: A Cross-Country Analysis', *Economic Analysis and Policy*, vol. 40, no. 2, pp. 249-61.

Chatterjee, A. et al. 2014, 'Checkup Time Chronic Disease and Wellness in America: Measuring the Economic Burden in a Changing Nation', The Milken Institute, Santa Monica, Calif., January, at www.chronicdiseaseimpact.com

Collins, J.J. et al. 2005, 'The assessment of chronic health conditions on work performance, absence, and total economic impact for employers', *Journal of Occupational and Environmental Medicine*, vol. 47, no. 6, pp. 547-557.

Cortez, R. 2000, 'Health and productivity in Peru: Estimates by gender and region', in W.D. Savedoff and T.P. Schultz (eds), *Wealth from Health: Linking Social Investments to Earnings in Latin America*, Bank, Washington DC.

Cortes, R. 2001, Cortez, R. 2001, 'Impact of public services on productivity and health', in Centro de Investigacion y Desarollo (CIDE), *Dimensiones de Pobreza en el Peru: Crecimiento Económico, Educación y Salud, Análisis de la Encuesta Nacional de Hogares* (Dimensions of Poverty in Peru: Economic Growth, Education and Health, Analysis of the National Household Survey), Lima, pp. 151-181. At http://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib0488/Libro.pdf

Danaei, G. et al. 2011a, 'National, regional, and global trends in systolic blood pressure since 1980: systematic analysis of health examination surveys and epidemiological studies with 786 country-years and 5·4 million participants', *The Lancet,* vol. 377, pp. 568-577.

Danaei, G. et al. 2011b, 'National, regional, and global trends in fasting plasma glucose and diabetes prevalence since 1980: systematic analysis of health examination surveys and epidemiological studies with 370 country-years and 2·7 million participants', *The Lancet*, vol. 378, pp. 31-40.

Davis, K. et al. 2005, 'Health and Productivity Among U.S. Workers', Issue Brief August 2005, The Commonwealth Fund, Washington DC, at http://www.commonwealthfund.org/usr_doc/856_Davis_hlt_productivity_USworkers.pdf

DeVol, R. et al. 2007, 'An Unhealthy America: The Economic Burden of Chronic Disease, Charting a New Course to Save Lives and Increase Productivity and Economic Growth', The Milken Institute, Santa Monica, Calif., October, at www.chronicdiseaseimpact.com

Fang Pengqian et al. 2011, 'How many working days would be missed due to moderate or severe influenza pandemic in China?', *Scandinavian Journal of Public Health*, vol. 39, pp. 656-664.

Farzadfar, F. et al. 2011, 'National, regional, and global trends in serum total cholesterol since 1980: systematic analysis of health examination surveys and epidemiological studies with 321 country-years and 3·0 million participants', *The Lancet*, vol. 377, pp. 578-586.

Finucane, M.M. et al. 2011, 'National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9·1 million participants', *The Lancet*, vol. 377, pp. 557-567.

Goetzel, R.Z. et al. 2004, 'Health, absence, disability, and presenteeism cost estimates of certain physical and mental health conditions affecting U.S. employers', *Journal of Occupational and Environmental Medicine*, vol. 46, no. 4, pp. 398-412.

Heidenreich, P.A. et al. 2011, 'Forecasting the future of cardiovascular disease in the United States: A policy statement from the American Heart Association', *Circulation*, vol. 123, pp. 933-944.

Indran, S.K., Gopal, R.K. and Omar, A. 1995, 'Absenteeism in the workforce, Klang Valley, Malaysia: Preliminary report', *Asia Pacific Journal of Public Health*, vol. 8, no. 2, pp. 09-13.

Institute for Health Metrics and Evaluation (IHME) 2010, 'Global Burden of Disease Study 2010 (GBD 2010) Data Downloads', Seattle, at http://ghdx.healthdata.org/global-burden-disease-study-2010-gbd-2010-data-downloads

International Labour Organization (ILO) 2014, ILOSTAT Database, Geneva, at http://www.ilo.org/ilostat/faces/home/statisticaldata?_afrLoop=3064170038134783#%40%3F_afrLoop%3D3064170038134783%26_adf.ctrl-state%3Dkpuvr3vj9_4

KPMG Econtech 2011, 'Economic Modelling of the Cost of Presenteeism in Australia: 2011 Update', Report for MediBank Private, August 2011.

Lai, C.K.W. et al. 2006, 'Cost of asthma in the Asia-Pacific region', *European Respiratory Review*, vol. 15, no. 98, pp. 10-66.

Langley, P.C. et al. 2011, 'The impact of rheumatoid arthritis on the burden of disease in urban China', *Journal of Medical Economics*, vol. 14, no. 6, pp. 709-719.

Lu, C. 2009, 'The impact of mental health on labour market outcomes in China', *The Journal of Mental Health Policy and Economics*, vo. 12, no. 1, pp. 157-168.

Luerssen, J.S. 1993, 'Illness and household reproduction in a highly monetized rural economy: A case from the southern Peruvian highlands', *Journal of Anthropological Research*, vol.49, no.3, pp. 255-281.

Min Hu and Wen Chen 2009, 'Assessment of total economic burden of chronic Hepatitis B (CHB)-related diseases in Beijing and Guangzhou, China', *Value in Health*, vol. 12, supp. 3, pp. S89-S92.

Murray, C.J.L. et al. 2012, 'GBD 2010: Design, definitions, and metrics', *The Lancet*, vol. 380, pp. 2063-2066.

Murrugara, E. and Valdivia, E. 2000, 'The returns to health for Peruvian adults by gender, age, and across the wage distribution', in W.D. Savedoff and T.P. Schultz (eds), *Wealth from Health: Linking Social Investments to Earnings in Latin America*, Bank, Washington DC

Ng, M. et al. 2014, 'Smoking prevalence and cigarette consumption in 187 countries, 1980-2012', *JAMA*, vol. 311, no. 2, pp. 183-192.

Pan, J., Qin, X. and Liu, G.G. 2013, 'The impact of body size on urban employment: Evidence from China', *China Economic Review*, vol. 27, pp. 249-263.

PricewaterhouseCoopers (PWC) 2014, 'Creating a Mentally Healthy Workplace Return on Investment Analysis', March 2014, PWC, at http://apo.org.au/node/39705

Salomon, J.A. et al. 2012, 'Common values in assessing health outcomes from disease and injury: Disability weights measurement study for the Global Burden of Disease Study 2010', *The Lancet*, vol. 380, pp. 2129-2143.

Saroja, K.I. et al. 1999, 'Trends in absenteeism rates following psychological intervention-preliminary results', *Singapore Medical Journal*, vol. 40, no. 5, pp. 349-351.

Schofield D.J. et al. 2011a, 'The personal and national costs of mental health conditions: Impacts on income, taxes, government support payments due to lost labour force participation', *BMC Psychiatry*, vol. 11, pp. 72-79.

Schofield D.J. et al. 2013b, 'The personal and national costs of lost labour force participation due to arthritis: An economic study', *BMC Public Health*, vol. 13, pp. 188-197.

Schofield D.J. et al. 2014, 'The economic impact of diabetes through lost labour force participation on individuals and government: Evidence from a microsimulation model', *BMC Public Health*, vol. 14, pp. 220-227.

Schofield, D.J. et al. 2008, 'Chronic disease and labour force participation among older Australians', *Medical Journal of Australia*, vol. 189, pp. 447-450.

Schofield, D.J. et al. 2011b, 'Projecting the impacts of illness on labour force participation: An application of Health&WealthMOD', *International Journal of Microsimulation*, vol. 4, no. 3, pp. 37-47.

Schofield, D.J. et al. 2011c, 'Economic impacts of illness in older workers: Quantifying the impact of illness on income, tax revenue and government spending', *BMC Public Health*, vol. 11, pp. 418-424.

Schofield, D.J. et al. 2013a, 'The personal and national costs of CVD: Impacts on income, taxes, government support payments and GDP due to lost labour force participation', *International Journal of Cardiology*, vol. 166, pp. 68-71.

United Nations 2014, 'World Population Prospects: The 2012 Revision', Department of Economic and Social Affairs, Population Division, Populations Estimates and Projections Section, New York, at http://esa.un.org/unpd/wpp/unpp/panel_population.htm

World Health Organization (WHO) 2014, *World Health Statistics 2014: Part III Global Health Indicators*, Geneva, at http://www.who.int/gho/publications/world_health_statistics/EN_WHS2014_Part3.pdf?ua=1

World Health Organization (WHO) 2009, *Who Guide to Identifying the Economic Consequences of Disease and Injury*, Department of Health Systems Financing Health Systems and Services, WHO, Geneva, at http://www.who.int/choice/publications/d_economic_impact_guide.pdf

Yang, G. et al. 2013, 'Rapid health transition in China, 1990-2010: Findings from the Global Burden of Disease Study 2010', *The Lancet*, vol. 381, pp. 1987-2015.

Zhen Hong et al. 2009, 'Economic burden of epilepsy in a developing country: A retrospective cost analysis in China', *Epilepsia*, vol. 50, no. 10, pp. 2192-2198.

Zhong, Y. and Li, D. 1995, 'Potential years of life lost and work tenure lost when silicosis is compared with other pneumoconioses', *Scandinavian Journal of Work, Environment and Health*, vol. 21, supp. 2, pp. 91-94.