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Global Review of Projecting Health Expenditures for Older Persons in Developing Countries

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Dr Ravi P. Rannan-Eliya*
Dr Ruki Wijesinghe
Institute for Health Policy
Colombo, Sri Lanka
http://www.ihp.lk

Correspondence to Ravi P. Rannan-Eliya at ravi@ihp.lk

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Abbreviations

ADL – Activities of Daily Living
AIHW – Australian Institute of Health and Welfare
AHEAD – Ageing, Health Status and Determinants of Health Expenditure
CASMU – Centro de Asistencia del Sindicato Medico del Uruguay
CMS – Centers for Medicare and Medicaid Services
FEM – Future Elderly Model
GAD – Government Actuary's Department
GDP – Gross Domestic Product
GNP – Gross National Product
DHA – Domestic Health Accounts
DoH – Department of Health
EHHUES – Egyptian Household Health Care Use and Expenditure Survey
HALS – Health and Activity Limitation Survey
HCE – Health Care Expenditure
HCFA – Health Care Financing Administration
HOMES – Household Model for Economic and Social Studies
HSFRM – Health Sector Finance Reform Model
IADL – Instrumental Activities of Daily Living
ICHA – International Classification for Health Accounts
IIASA – International Institute for Applied Systems Analysis
LDC – Less Developed Countries
LTC – Long-term Care
MMA – Medicare, Prescription Drug, Improvement and Modernization Act
MCBS – Medicare Current Beneficiary Survey
MDC – More Developed Countries
M/F – Male/Female
MOH – Ministry of Health
MoPH – Ministry of Public Health
NBER – National Bureau of Economic Research
NHA – National Health Accounts
NHE – National Health Expenditure
NHIS – National Health Interview Survey
NHS – National Health Service
NPHS – National Population Health Survey
NUPRI – Nihon University Population Research Institute
OASDI – Old Age and Survivors Insurance and Disability Insurance
OECD – Organization for Economic Cooperation and Development
PHC – Personal Health Care
PSSRU – Personal Social Services Research Unit
RCHSP – Joint OECD/Korea Regional Center for Health and Social Policy
SHA – System of Health Accounts
SS – Social Security
SSA – Social Security Administration
UN – United Nations
WB – World Bank
WHO – World Health Organization

Keywords

Ageing, health expenditure, forecasting, projection models, actuarial approach, compression of morbidity, health systems

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EXECUTIVE SUMMARY

The growth in the size of the world's population is slowing, and the major feature of demographic change is increasingly population ageing – the growth in the share of the population which is elderly. The process is most advanced in the developed countries, but has already started in many developing countries, and will take place rapidly in many of them during this century.

It is universal that the elderly use more health care services than the young. This leads naturally to the expectation that population ageing will result in escalating health care costs. However, analysis of historical trends in health care spending in the developed countries, which are most advanced in the process of ageing, does not support this. In these countries, ageing has had no detectable or only a modest effect on health care costs. To explain why this is the case, it is necessary to adopt a more elaborate framework for thinking about how ageing affects health care spending. The future cost of health services is the product of both the utilization of services and the unit cost or price of those services. The impact of ageing in such a framework is not obvious.

Ageing does lead to an increase in aggregate utilization of services. However, other factors have a larger impact on future use, including changes in access to services, education and health norms. The unit cost or price of services is not fixed, and may increase or decrease. In addition, there is evidence from developed countries to support the idea that morbidity is being compressed at higher age groups, and that a large proportion of current age-related expenditures will shift into higher ages. If this is the case, ageing may not result in as substantial an increase in per capita expenditures in the long term.

Several projection methodologies have been used to forecast future health spending. Of these, the most feasible and useful for examining the impact of ageing on health care spending is the actuarial approach. This is the most widely used methodology, but has been used mostly in developed countries. A review of the literature indicates that very few studies of the impact of ageing on future health care costs have been undertaken in developing countries. The few that have been conducted do indicate that such studies are feasible, and also point to similar conclusions to that of studies in developed countries. The most important of these are that ageing is not the main or dominant driver of future health care costs, and that other factors more amenable to policy intervention have more impact. These include decisions over health care financing, policies that shape productivity and medical price inflation, and technology adoption and diffusion policies.

Projection models are most useful in helping policy-makers understand key issues, and to place population ageing in perspective. Encouraging more work in this field in developing countries should be a high priority. Related to this, a global research priority must be to explore systematically whether compression of morbidity is occurring in developing countries, as the answer to this has substantial policy implications.

It is recommended that WHO Kobe Centre lead and collaborate with others to stimulate such work, and an immediate priority should be a multi-country collaborative research effort to apply a common actuarial projection model approach to develop comparable estimates of future health spending in a diverse group of developing countries.

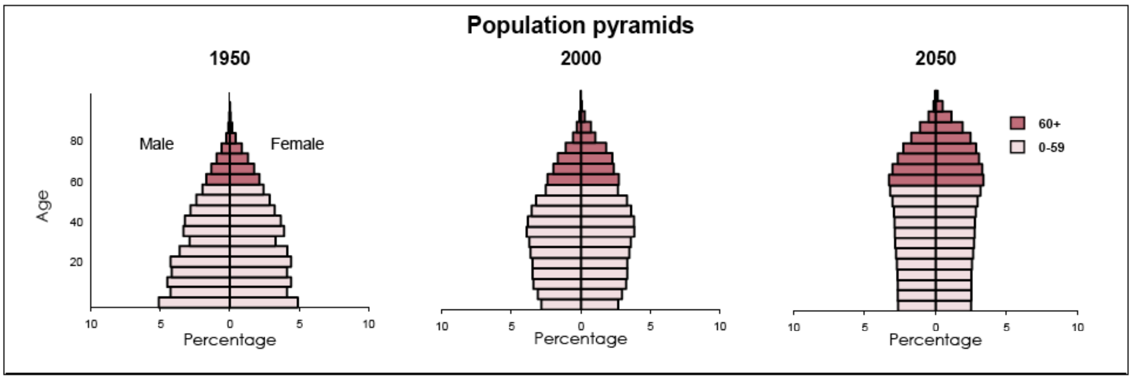
1. AGEING OF THE WORLD'S POPULATION

1.1 Ageing – a global transition

The world's population is ageing, an inexorable consequence of modernization and economic development. In the three centuries since the start of industrialization in the early 1700s, mortality and birth rates have fallen around the globe. This dual transition in mortality and fertility started first in the countries of northern Europe, spread subsequently to Japan, North America and Australasia, and has now reached all regions of the world, most recently Africa.

Historically, the reduction in birth rates has lagged behind the reduction in mortality rates. Until the mid-twentieth century, this process resulted first in an accelerating increase in the size of populations, with each new generation larger than the preceding one, and with the typical population structure in most countries adopting a pyramidal shape. As fertility declines have spread around the globe, the rate of increase in the size of populations has fallen, and in many countries has ceased, or indeed reversed as in countries such as Japan and Russia. Slower increase and stabilization of population size has in turn been accompanied by the ageing of the population, as the share of the population comprised by older age groups has begun to increase. This can be seen as a process of adjustment as the age structure of population shifts from a situation of high birth rates, low mortality rates and net population growth to a situation where both birth and mortality rates are low and population growth itself has ceased (Figure 1.1). The population pyramid shifts from a pyramidal shape to a cylindrical shape with most deaths concentrated at the highest age groups. But while this occurs, the numbers of older people will increase faster than those of younger people, and the average age of the population will increase.

Figure 1.1: Changing age structure of the population in developed countries, 1950-2050



Source: United Nations Population Division (2003), "World Population Ageing 1950-2050."

These global transformations in the size and structure of the world's population are the benefits of the process of economic modernization and the associated improvements in scientific and medical knowledge. They are in fact amongst the most significant achievements of human development. People are healthier than ever in human history, they are living longer than ever before, their children are far more likely to reach adulthood than not, and they can choose to have fewer offspring than before.

Population ageing should thus be regarded as a welcome and happy development. However, it has become an increasing source of anxiety to societies and countries for two reasons:

1. Adults in the older age groups (60 years and above) have traditionally been sicker and more infirm than the young, and therefore an increase in the numbers of older persons is usually anticipated to increase the demand and need for medical and social services.
2. The worldwide norms and expectation that individuals cease active work during their sixth decade, and the increasing desire of individuals to follow years of work by many years of retirement freed from the necessity of toil creates a significant challenge to societies on how these increasing years of leisure will be afforded.

These issues have already risen in salience to occupy prominent positions in the policy agendas of developed countries. Already the provision of pensions and social security is for many countries in the developed world the leading social and economic policy issue. It will inevitably become so in developing countries in the future. However, this review focuses on the first issue, which is the impact of future ageing on health care services. The key questions for today are (i) to what extent will ageing of the population will present future challenges for the financing of health care in developing countries, and (ii) how can such future challenges be quantified? The objectives of this paper are to review what we know about the first, and what methods are likely to be required for answering the second.

In thinking about the implications of ageing for future health care financing needs, it is useful to bear in mind two aspects of these questions. First, if expenditures on health care for the elderly are the same as for the rest of the population, then it should not matter how much is spent proportionately on the elderly. It is only because there are reasonable grounds to believe that spending for the elderly does differ that there is potential interest in what the fraction of spending is for the elderly. Second, the concern is often not just with the fraction of spending that is for the elderly, but also the overall absolute amounts, and the extent to which the increased numbers of elderly add to overall aggregate of spending.

1.2 Future ageing trends

The world's population is currently 6.5 billion (United Nations Population Division, 2005), and is expected to increase to 9.1 billion by 2050. Almost the entire increase is expected to take place in developing countries, where the population will increase from 5.3 billion to 7.8 billion by 2050. In contrast, the population in developed countries will remain largely unchanged at 1.2 billion. Therefore, in developed countries, demographic change will largely involve an ageing of the population, whilst in developing countries ageing will accompany further increases in population size.

According to the most recent UN population projections, the share of the elderly (defined as those aged 65 years and above) is expected to increase from 7.4 percent of the world's population today to 16.1 percent by 2050. In the developed countries, the percentage is expected to increase from 15.3 percent to 25.9 percent, and in the developing countries from 5.5 percent to 14.6 percent by 2050. This increase in developing countries in fact hides significant regional differences, with the increase being mostly in Europe and the least in Africa (Table1.1). This ageing in the population is also characterized by an increase in the median age of all populations (Table 1.2).

Table 1.1: Percentage of population aged 65 years and above, 2000-2050 (%)

Region	2000	2025	2050
More developed	14.3	20.8	25.9
Less developed	5.1	8.6	14.6
Least developed	3.2	4.0	6.6
Africa	3.3	4.2	6.7
Asia	5.9	10.2	17.5
Europe	14.7	21.0	27.6
Latin America and Caribbean	5.6	10.1	18.4
Northern America	12.4	18.0	21.1
Oceania	9.7	14.8	19.3

Source: UN World Population Prospects: The 2004 Revision

Table 1.2: Median age of population, 2000-2050 (%)

Region	2000	2025	2050
More developed	37.3	43.1	45.5
Less developed	24.3	30.8	36.6
Least developed	18.3	21.8	27.3
Africa	18.4	21.8	27.4
Asia	26.2	33.7	39.9
Europe	37.6	44.4	47.1
Latin America and Caribbean	24.4	32.3	39.9
Northern America	35.4	38.8	41.5
Oceania	31.2	36.4	40.5

Source: UN World Population Prospects: The 2004 Revision

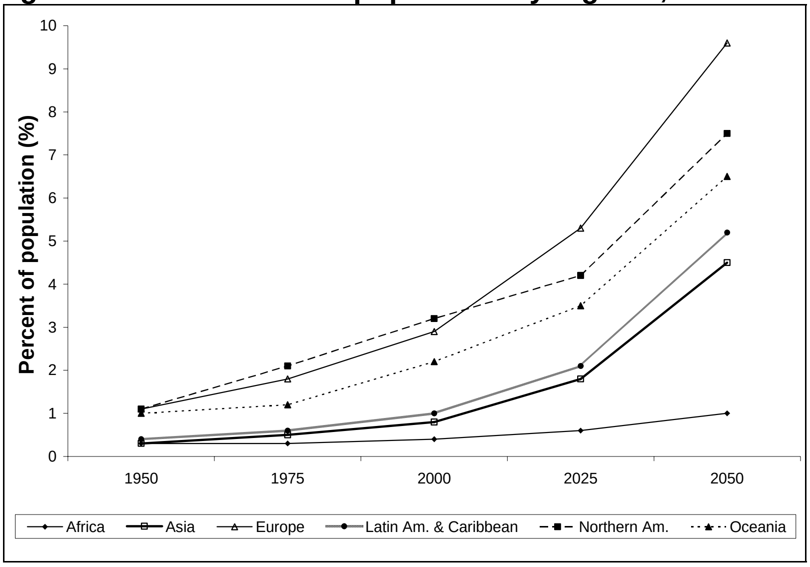
Table 1.3: Percentage of population aged 80 years and above, 2000-2050 (%)

Region	2000	2025	2050
More developed	3.1	5.4	9.4
Less developed	0.7	1.4	3.6
Least developed	0.3	0.5	1.0
Africa	0.4	0.6	1.0
Asia	0.8	1.8	4.5
Europe	2.9	5.3	9.6
Latin America and Caribbean	1.0	2.1	5.2
Northern America	3.2	4.2	7.5
Oceania	2.2	3.5	6.5

Source: UN World Population Prospects: The 2004 Revision

More significant than the increase in the share of the population aged 65 years and above is the increase in the share of the “oldest-old”, those aged 80 years and above (Table 1.3). Although their numbers are smaller, they will increase more rapidly than those of the overall elderly (Figure 1.2). It is this group that potentially presents the greatest challenges for financing and health and social service provision. Their numbers will increase substantially in developing countries in this century.

Figure 1.2: Growth in 80+ population by regions, 1950-2050



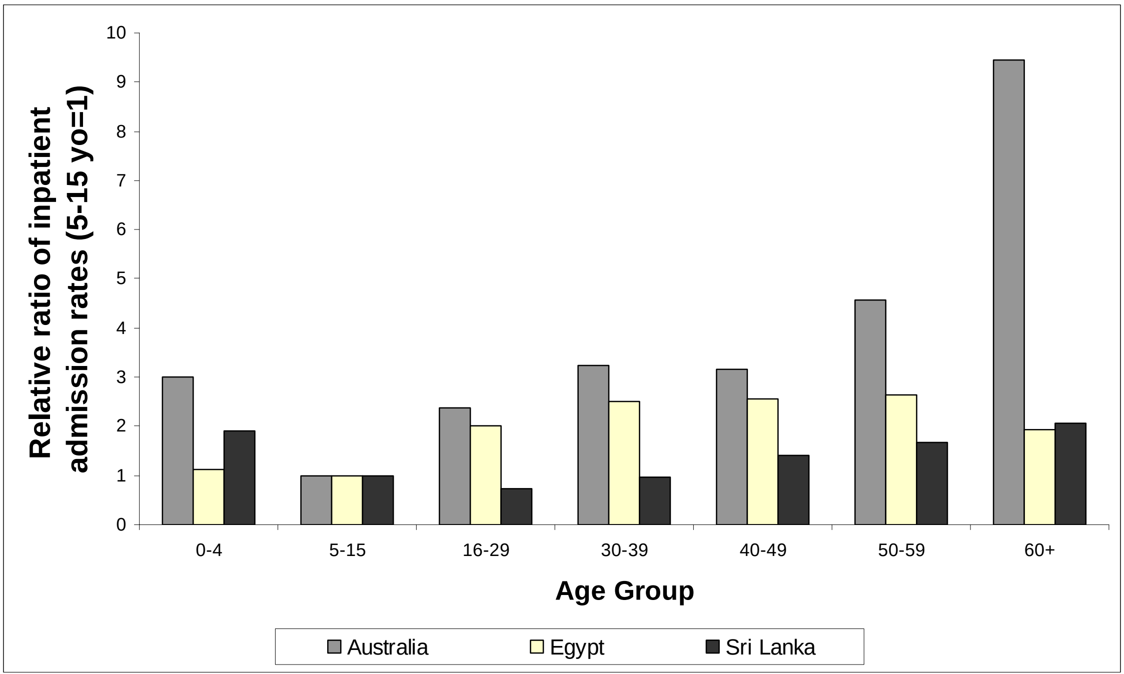
Source: UN World Population Prospects: The 2004 Revision

2. THE CONSEQUENCES OF AGEING FOR THE DEMAND AND COST OF HEALTH CARE

2.1 The relative use of health care by the elderly compared with the young

The elderly use health care services with greater frequency and in greater intensity than younger adults. This is both self-evident and easily confirmed by examining any data on the relative use of health services by different age groups. The rate of health care utilization rapidly declines after birth and the first year of life, and reaches its minimum in adolescents and young adults in the age group 14-25 years. Health care use then generally shows a small increase with age until the age of 50-60 years, when it begins to substantially rise. This pattern of health care use with age is universal, and appears to hold in both developed and developing countries, as illustrated in Figure 2.1.

Figure 2.1: Utilization of health care services by age, selected countries



Source: Berman *et al.* (1998), Rannan-Eliya (2005) and AIHW (2006)

It must be noted that in several developed countries, reports demonstrate that rates of health care use may actually peak in the age group 75-85 years, and fall modestly in older age groups. This may be because those who survive to reach such advanced ages tend to be much healthier individuals than the average, or because the very elderly are less inclined to seek medical care when sick. The data are not available to examine this for most developing countries since, typically, the numbers of the very elderly in health surveys, which are used to examine this, tend to be small. Nevertheless, data from some developing countries, such as Sri Lanka, do also appear to be consistent with this pattern.

2.2 Evidence for the impact of ageing on health care expenditure

Since the elderly do use more health services than the young, the notion that ageing of the population will increase the demand and cost of health services tends to follow naturally. It is so well established that it is often treated as a truism. However, it has been difficult to show empirically that population ageing is definitively associated with net increases in aggregate health expenditure at the national level (Chernichovsky and Markowitz, 2004; Mahal and Berman, 2001). The reality is that the linkages between ageing and health spending are, in fact, much more complex than usually thought of.

Health economists have devoted considerable efforts to disentangling the drivers of health care spending by using econometric techniques to analyze the association between indicators of ageing and the trends in national health expenditure. Almost all of these analyses have examined spending patterns only in countries of the Organization for Economic Cooperation and Development (OECD), making use of the OECD compiled databases on national health expenditure. These analyses have examined the relationship between aggregate health expenditures as a share of GDP and in per capita dollar terms, and per capita income, indicators of ageing and other macro-variables, including in a few cases characteristics of national health systems. These analyses have been of two types. Some have examined variations in per capita spending across countries (Getzen, 1992; O'Connell, 1996; Roberts, 1999), and others have examined cross-country differences in the growth rates in per capita health spending (Barros, 1998).

In general, most have reported that ageing or the elderly share of the population is not a statistically significant determinant of national health spending or its increase over time. For example, Barros (1998) examined the relationship between the share of the population aged 65 and older and national health expenditure, and found that it was not a statistically significant determinant of the growth in health spending. A smaller number of studies have reported ambiguous results. O'Connell (1996) examined the relationship between the share of the elderly population and growth in health spending in OECD countries between 1975 and 1990. She used a number of different statistical models, and in some of these ageing was significant, and some models suggested that the impact of ageing varied across countries. In her study, ageing had a statistically significant effect in several countries, including United States and Canada, but no or negative effects in others. Other authors have occasionally reported similarly positive results, but in most cases these have been sensitive to the details of the statistical models used (Gerdtham *et al.*, 1992).

The main conclusion that one can draw from these studies is that for developed countries, the share of the population that is elderly does not have a substantially positive impact on overall health spending, nor on increases over time. Although this may change in the future, any impacts have been modest, at best over the period 1960-2000, which are the years that have been most intensively examined.

No similar studies examining the impact of ageing on a group of countries exist for developing countries. This is because the necessary data have not been available. We simply lack reliable time series data on national health expenditure over many years for any significant number of developing countries. Research on OECD countries has benefited from the efforts of the OECD to compile systematic data on national health spending in its member states. These OECD estimates of annual health spending are available for most OECD countries for the period from 1960, and are published in the annual OECD Health Data publication. Although WHO now publishes and maintains a database on national health expenditures that covers all countries, the data for developing countries is for the most part unreliable and not robust enough to support the time series panel data analyses that have been carried out for OECD countries. However, it is likely that with the increase in the past few years in the number of developing countries that report annual national health expenditure estimates using international standards, it will be feasible in the next decade to start conducting such studies for non-OECD countries. This may first be feasible for non-OECD countries in the European region (mostly in Central and Eastern Europe), and in the Asia-Pacific region. In the latter case, the possibility of much improved comparative time series data for non-OECD countries has recently been much increased by the recent agreement of WHO, OECD and the Asia-Pacific NHA Network (APNHAN) to collaborate in future in the joint annual collection of health accounts estimates from SEAR and WPR countries (Joint OECD/Korea Regional Centre on Health and Social Policy (RCHSP), 2006).

2.3 Ageing and health care costs – a framework

The econometric analyses of national health expenditure data demonstrate that either ageing has no large impact on health spending at the national level, or that there are several other variables that influence spending levels in conjunction with ageing, some of which may serve to reduce spending. These analyses have been carried out for developed countries, which have experienced the largest growth in the share of the elderly, so it is unlikely that larger undetected effects of ageing on health care costs have already occurred in developing countries.

The results point to the need to be more specific about the mechanisms by which we expect ageing to impact on health care expenditure. At the same time, it is evident that older people consume more health care services and require higher health expenditures than younger adults. How can this apparent paradox be explained?

To understand this, it is necessary to adopt a more comprehensive framework to analyze the links between ageing and health care expenditure. As a first step, it is useful to think about aggregate health spending as being the outcome of two factors: (i) the use of health care services, and (ii) the cost or price of those health care services. Total health care spending can then be shown as follows, using the notation of Chernichovsky *et al*. (2004):

$$H(t) = \sum N_i(t) U_i(t) . P_i(t) \qquad (1)$$

where $H(t)$ is aggregate health spending in period t; $N_i(t)$ is the number of people in age group i in period t; $U_i(t)$ is the average quantity of health care services per capita used by persons in age group i; and $P_i(t)$ is the average unit price of health care services consumed by persons in age group i.

Health spending as a percentage of national income can then be written as:

$$h(t) = H(t) / Y(t) \qquad (2)$$

$$h(t) = \left[\sum N_i(t) U_i(t) . P_i(t)\right] / Y(t) \qquad (3)$$

Where $h(t)$ is the ratio of health spending to national income or GDP, and $Y(t)$ is the GDP.

The elderly share of the population is given by:

$$Elderly\ ratio\ = \frac{N_O(t)}{\sum N_i(t)} \qquad (4)$$

Where subscript O refers to those in the elderly age group. Ageing is a process that involves changes in this ratio.

Written in this way, we can see that if the elderly use health services at the same rate and in the same intensity as other age groups, this is equivalent to saying $U_O = U_{i \neq O}$, and $P_O = P_{i \neq O}$. In this scenario, ageing, which is an increase in the elderly ratio, would have no impact on overall aggregate health spending, although it would alter the relative share of health spending accounted for by the elderly.

So ageing only has an implication for aggregate health spending if the frequency of use of health services (U_i) by the elderly differs from that by other age groups, and/or the intensity or relative cost of services (P_i) differs. In fact, as discussed earlier in this section, the elderly do use services at different rates than the non-elderly, so U_i does vary by age group. It is this difference in health care use rates that leads to the presumption that ageing will result in changes in aggregate health spending, but note that the relationship defined in equation (1) implies that the net effect will also depend on variations in the relative cost of services used by different age groups (P_i).

This perspective implies that any factors that alter the use rates (U_i) of health care and any factors which affect the unit price of services (P_i) can affect overall aggregate health spending. So ageing in combination with other factors may not necessarily increase spending. Such factors that affect the age-specific levels of demand for health care and its use (U_i) include:

(2) Changes associated with the process of biological ageing, which influence levels of morbidity in each age group.
(3) Other epidemiological trends.
(4) Access to health care, which is influenced by prices, insurance, public policy regarding financing and delivery of services and physical barriers.
(5) Socio-cultural or non-economic factors that influence health-seeking behavior.

Factors that affect the unit price of services (P_i) include:

(i) Technological change, which can change the inputs used to treat an illness.
(ii) Inflation in the economy, which can change the cost of producing health care.
(iii) Changes in the price of medical services, independently of general inflationary factors.
(iv) Government or insurance-influenced changes in the pricing of medical care.
(v) Changes in the choice of medical provider or medical good used by patients, where this has implications for the average price paid.

In addition to the above, there is another type of change that has important implications. Ageing produces many changes in individual functioning. It is not necessary that all these changes be managed by the health care system. Changes in the role of the health care system in managing the process of ageing can also alter the rates of use of medical services and aggregate spending.

For each of these factors, evidence of their existence and substantive impact have been demonstrated. However, such effects are not always in one direction, and often can act to counter the cost-inflationary impacts of ageing.

2.4 Factors that influence the impact of ageing on health care spending

Changes in demand for health care related to biological changes with ageing

The fact that older adults are, on average, sicker and need more health care is beyond doubt. In all countries, and whether we focus on self-reported sickness, actual clinical measurements of morbidity or mortality rates, older adults especially above the age of 60 years, are sicker, and need and use more health care than younger adults. However, this difference in averages does not necessarily imply that the relationship between ageing and aggregate health care spending is so simple. In recent years, research has provided increasing evidence for two important ways in which this relationship may be altered. The first is the compression of morbidity (Fries, 1980), and the second is the concentration of lifetime health care spending in the last illness.

Morbidity compression

Increasing life expectancy does not imply that only the age of average death is changing upwards or that the maximum lifespan of humans has increased. For most of human history, the lifespan of the very large majority of individuals has fallen far below the biblical three score and ten years (seventy years) or the maximum attained lifespan in the population. Increasing life expectancy can be consistent with individuals, on average, living longer free of sickness and death, but without any increase in the maximum attainable lifespan. In this situation, ageing of the population can be associated with increasing numbers of older people, but not necessarily increasing relative numbers of sick persons at any given time, since the increase in life expectancy is associated with increases both in the numbers of healthy adults as well as sicker adults. Increasing life expectancy may be associated with postponement of the average age at which chronic disability and infirmity occurs, with the bulk of disability and morbidity compressed into a shorter period or fraction of the average human life. Drivers for this would include the reduction in morbidity and mortality from acute diseases during young adulthood, and the possibility that chronic disease morbidity may fall in future with reductions in the prevalence of risk factors for non-communicable disease. If this is the case, it is quite possible for the average person to live longer, but for their average annual use of health services over their lifetime not to increase. Moreover, it is entirely possible that the average need for health care in any given year during their lifetime could even fall.

Since the compression of morbidity hypothesis was first proposed by Fries (1980), there has been a growing body of empirical data in support of its predictions. In the USA, survey data collected in the National Health Interview Study and the National Long-Term Care Study show that disability in adults has been declining at 2 percent a year since the early 1990s (Manton and Gu, 2001), and that the decline in disability in the elderly population (those aged 65 years or more) has been twice as fast as the decline in mortality, which was 1 percent per year. More recently, evidence of morbidity compression in the form of declining disability rates in the elderly accompanying falls in mortality have been reported from several OECD countries with longitudinal population surveys, including Australia, France, Germany, Japan, and the USA (Jacobzone *et al.*, 1998). The compression of morbidity hypothesis is further substantiated by the evidence that age-specific morbidity and mortality rates for many non-communicable diseases have been declining in several developed countries. For example, in the USA age-adjusted death rates from cardiovascular disease have declined 60% since 1950, and similar declines have been observed for strokes. These improvements in health have been attributed to reductions in smoking, lower blood pressure and cholesterol levels, improved diet and advances in medical care.

Although morbidity compression has evidently not led to reductions in health spending as a share of GDP in the USA during the past decade, it remains, nevertheless, an important mechanism by which the impact of ageing on aggregate health care spending in other countries may be mitigated. However, we lack any evidence for the occurrence of morbidity compression in developing countries. Although it has been argued that general conditions are such in developing countries that it is unlikely to be occurring (Kalache, Aboderin, and Hoskins, 2002), this view does seem overly pessimistic. Many developing countries have been experiencing sustained reductions in mortality and increases in life expectancy, as well as increasing levels of education and health care provision: it is reasonable to expect that compression of morbidity is also occurring in some of these.[1] However, there is limited data to assess this, because the necessary data sources, namely longitudinal population surveys with standardized questions on morbidity and disability, do not currently exist for developing countries. Even if such surveys are being carried out, their sample sizes would need to be larger than in developed countries, as the percentage of the population in the oldest age groups is generally smaller in developing countries, or such surveys would need to be restricted to the elderly only.

Concentration of expenditures in last year of life

A related empirical observation that is similar to the notion of compression of morbidity is the finding that a large fraction of the lifetime health care expenditures of the average individual are incurred in the last six months or year of life during their terminal illness. The earliest study in this area, by Piro and Lutins (Piro and Lutins, 1973), found that the 5 percent of US Medicare beneficiaries who died in 1967 accounted for 22 percent of all Medicare expenditures. Subsequently, other studies found that a large percentage of all medical expenditures, in the range of 10-30%, are incurred in the last 12 months of life of the average person, with such findings reported from several developed countries other than the USA (Scitovsky, 1984, 1988), including Norway (Nord, Hjort, and Heiberg, 1989), Netherlands (Stooker *et al.*, 2001) and the UK (O'Neill *et al.*, 2000; Wanless, 2001).

Again, as is the case with compression of morbidity, there appear to be no estimates available from developing countries on the percentage of lifetime expenditures incurred in the last year of life. However, one recent study has reported the finding in India that hospitalization episodes associated with death are more costly and resource-intensive for households than average (Gumber, 2005). The lack of research is probably because studies of this topic generally require access to high quality data on overall health expenditures, which are difficult to find outside the context of public insurance programs that are prevalent in developed countries. Nevertheless, there is no *a priori* reason to suppose that medical expenditures are not concentrated in a similar fashion in developing countries.

To the extent that a large proportion of lifetime medical expenditures are related to the final illness of an individual, much of the age-related distribution in expenditures is, in fact, driven by the higher frequency of deaths at higher ages. Since all of us can only die once, the increase in life expectancy that drives ageing does not increase the frequency of such end-of-life expenditures, but merely postpones such expenditures to the last year of life. If this is the case, if such end-of-life expenditures are ignored, much of the age-associated increase in annual medical expenditures may be removed.

[1] If this phenomenon does not occur in developing countries, it would raise the much more important question as to why not, and in turn imply that there are substantial areas in which policy in developing countries can improve morbidity in older adults.

That is, ageing, which is associated with a concentration of deaths at higher ages, simply concentrates an increasing percentage of lifetime expenditures into the last years of life, but does not actually result in an increase in lifetime expenditures. Evidence for this possibility has, in fact, been reported for some countries, such as Switzerland (Zweifel, Felder, and Meiers, 1999). This phenomenon implies that much of the impact of ageing on future expenditures is extrapolated from current observations of age-related variations in expenditures may indeed be exaggerated.

Changes in demand for health care related to changes in access to health care

An important factor affecting the demand and use of health care is access. Generally, as health systems develop, this improves, because of increased supply of services and associated increases in physical accessibility and the establishment of financing arrangements that reduce the financial barriers to services. Financial access increases as individual incomes increase and households become more able to finance their medical care with increases in discretionary expenditure. The expansion of financial access to services has, however, generally been achieved by the introduction of public insurance for medical care, either through formal insurance schemes, or through public sector financing of public sector medical provision. Chernichovsky et al. (2004) point out that since historically, extensions of insurance and public entitlements to the elderly have followed after their initial extension to pregnant women and children, and then working adults, the process of ageing is typically accompanied by a process of entitlement expansion in many countries.

Whatever the general relationship is between population ageing and expansions in insurance coverage and public entitlements, the main issue is that such factors play an important, if not overwhelming, role in determining aggregate health spending. Developed countries, for example, spend a greater share of their national income on health services, not because their populations are older, but because they have more generous arrangements for public financing of medical services both for the young and for the elderly. The critical implication for developing countries is that such changes in financial access may have much larger impacts on aggregate spending than the effects of ageing.

Changes in demand for health care related to socio-cultural factors

The demand for health care services is not only a function of the health status of individuals and their ability to access needed medical services. A significant part of the observed demand is related to non-economic factors, including knowledge and social norms. In particular, education and knowledge about illness and treatment options is generally hypothesized to increase demand for medical care (Grossman, 2000).

It is reasonable to expect that better knowledge about available medical treatment options will increase demand for those services, and thus aggregate spending. Thus as the population becomes more educated in terms of schooling, and also as the average person's knowledge of medical services increases, demand should also increase. The theoretical expectations are borne out by the empirical evidence from many countries that education is associated with greater demand for medical services. Since, in most countries, each elderly cohort is more educated than the previous one, ageing should thus be accompanied by some increases in demand which are driven not by there being more elderly, but by each new generation of elderly demanding more health care services.

In addition to the impact of formal education, most societies experience increased societal knowledge and expectations about medical treatment over time. This also should act to increase demand for medical services, over and above the effects of increased schooling and formal knowledge. This is, in fact, consistent with the evidence from around the world, which is that the underlying level of demand for medical services has increased more than what one would expect from simple increases in education and income, and despite improvements in underlying health status (Rannan-Eliya, 2004). In developed countries, where education levels are not dramatically increasing, there is evidence from many countries that the rates of resort to medical treatment in each age group are in fact increasing over time, despite improvements in population health. Such changes, which we may term secular changes in demand, have typically been reported to be as much as 1 to 2 percent per annum (Wanless, 2001; Rannan-Eliya, 2004). Similar rates of change have also been reported from at least one developing country where this has been examined, Sri Lanka (Rannan-Eliya, 2005).

At the same time, it can be argued that the actual relationship between education and demand is more ambiguous since education may enable individuals to use non-medical inputs or healthier lifestyles to become more efficient users of medical treatment or to remain healthier longer. In this case, rising levels of education would act to reduce demand for medical services by the elderly. Chernichovsky *et al.* (2004) provide evidence for this dynamic from Israel using public insurance data. This suggests that the impact of non-economic factors on demand for medical services over time by the elderly is likely to be the outcome of a complex interaction of both positive and negative factors, although the evidence, in general, suggests that the net impact remains positive for those countries where these trends can be studied.

The impact of technological change on the price of medical services

In most sectors of the economy, technological change usually implies cheaper ways of producing services and goods than existing methods. However, a characteristic of the health sector is that technological change often involves the introduction of new technologies that improve health outcomes, but at an increased price. In many cases, the increased price costs more than any cost savings from the improved effectiveness of the technique or intervention, but societies, individuals or those who finance health care are still willing to spend the additional money involved to obtain the marginal improvements in benefits. Technology is thus often, or mostly cost-increasing, in its impact on medical services (Weisbrod, 1991).

In empirical work, technological change has long been identified as a factor increasing aggregate health spending, with longitudinal studies of the growth of medical expenditures at the national level identifying part of the increase in spending as being due to technological change. Most of these studies have been from the USA (Newhouse, 1992), but the results have been confirmed for other developed countries, and would appear generalizable to developing countries.

If technological change was merely uniform in its impact, its only implication for future health care costs would be as a general inflationary factor, independent and, in addition to, any impacts of ageing. However, recent empirical work has identified a two-way relationship between ageing and the impact of technological change on health care spending. In the case of the USA, Fuchs states that there is consensus among health care experts that the major element underlying age-specific health expenditures is new technology. Other more recent work has found that technological change has played a key role in the reduction of mortality and morbidity in older adults in the USA, and that it is driving age-specific differences in the rate of change of per capita health expenditures (Cutler and Meara, 2001). Examples include the increasing use of angioplasty coronary bypass surgery in the treatment of ischemic heart disease, new procedures to manage the impact of osteoarthritis, and the use of new medicines to manage cholesterol levels and diabetes.

On one hand, there is firm evidence in developed countries that technological change is increasing the cost of medical care, that much of this technological change is directly contributing to the process of ageing by increasing life expectancy in the elderly via reductions in non-communicable disease mortality, and that it is contributing to more rapid increases in per capita expenditures for the elderly than for younger adults. On the other hand, there appears to be no comparable evidence from developing countries. However, it has to be noted that the types of data that have been used to examine these questions in developed countries do not generally exist in developing countries (e.g. reliable time series data on national health expenditures, public insurance data on spending and the choice of different types of intervention for specific diagnoses). Nevertheless, it is reasonable to expect similar trends to occur in many middle-income developing countries with expanding public insurance coverage.

The impact of price changes on the cost of medical care

In considering the impact price changes on future medical costs, we need to distinguish between general inflation in prices of all goods and services in the economy, and inflation specific to the medical sector. The first type of inflation is largely of little relevance when considering the future burden of aggregate health care spending. If medical prices rise at the same rate as other prices, then the nominal cost of medical care in future will be more, but will not change as a share of available resources or GDP.

In assessing the impact of ageing on future health care costs, the critical issue is the change in medical prices relative to that of other prices, i.e., health-sector specific inflation. As discussed earlier, medical inflation of this nature does exist, since technological development has generally added to medical costs. However, in addition to technological change, other factors can alter the costs of medical treatment; these include: (i) providers can employ more expensive inputs (e.g. pay higher wages or use higher wage personnel) to produce the same outputs, and (ii) productivity change can alter the amount of inputs required to produce a given service. The first is more relevant to health care services produced by private providers in a market setting, whilst the second is relevant to the public sector delivery of health care services. As with other factors that have been discussed, we have firm evidence of both types of changes in developed countries, but limited evidence from developing countries. Medical price inflation is well recognized in developed countries, and is argued to be a major reason for the high levels of medical spending in the USA, compared with other developed countries (Anderson *et al.*, 2003). Productivity change, which changes the average unit cost of delivering a medical service is well documented for many developed countries (Färe *et al.*, 1992; Wagstaff and Lopez, 1996; Australian Bureau of Statistics, 1998; Hensher, 2001), and is, in fact, routinely taken into account for planning purposes in several countries.

The impact of productivity change and price inflation on aggregate health care spending, in comparison to the impact of ageing, should not be underestimated. There are many studies which have found that such changes, which can have both positive and negative effects on spending, are much more substantial in their implications for aggregate spending than the effects of ageing in the population structure (Reinhardt, 2003; Wanless, 2001). For developed countries, productivity change is often a force that acts to reduce medical costs, whilst medical price inflation is more often discussed as having a positive impact. Moreover, medical inflation can have differential impacts on the costs of treatment for different age groups, and this can complicate the impact of ageing on aggregate health spending.

Unfortunately, the research on medical price inflation and productivity change in developing countries is very limited, and we can say little about the impact of these trends in developing countries. Hensher (2001) argued that, since there was no evidence, such changes are unlikely to occur in developing countries, but this seems both premature and unwarranted. In the few countries where efforts have been made to examine this, there is empirical evidence of productivity change leading to changes in the cost of delivering services (Rannan-Eliya, 2004; Rannan-Eliya, 2005). The main difficulty is that it is harder to find data to assess this in developing countries. Indeed, the process of productivity change in developing countries has been subject to considerable neglect by researchers.

The impact of policy on the cost of medical care

Governments and policy-makers can significantly alter the relationship between ageing and aggregate health spending (Mahal and Berman, 2001; Reinhardt, 2003). They can do this in a number of ways, both intentionally and most often unintentionally:

(i) Governments make the critical decisions to expand public financing, public insurance and entitlement programs to cover additional groups in the population, or to expand coverage for specific medical services. These choices historically have had the largest impacts on national health spending.

(ii) Governments are responsible for how public insurance programs pay providers and, in particular what prices they pay. The methods of payment and the prices that are paid often have a large impact on the evolution of medical prices and the cost of producing medical services in a country. This is argued to be the main factor behind the very high medical prices in the USA (Anderson *et al.*, 2003). Policy can also choose to pay for certain procedures or not, and this can have significant impacts on age-specific health expenditure trends: for example, Cutler and Meara (1999) argue that relaxations of Medicare reimbursement rules for payment of post-acute care for the elderly is one possible reason for the rise in these expenditures from the late 1980s.

(iii) Public policy can substantially influence the process of development of new medical technologies and their subsequent diffusion in the health sector (Fuchs, 1998). Governments can also make decisions to adopt new technologies or not, often on the grounds of cost.

(iv) Governments are largely responsible for the strategies, policies and rules, which determine the rate of productivity change in the public sector.

The fact that government intervention and public policy have an impact is important for two sets of reasons. First, it implies that we need to take into account such interventions when assessing the impact of ageing on future costs – public policies are an additional set of variables that influence aggregate spending. Second, it indicates that there are tools which policy-makers can use to alter the impact of ageing on aggregate health spending or mitigate its impact. Death may be inevitable, but the impact of ageing on health costs may be largely avoidable.

Changes in the role of the medical system in managing the process of ageing

An emerging issue is whether the medical system is used to manage aspects of the process of individual ageing. This is most commonly encountered in relation to the impact of changing social norms and household structure on the ability of households to care for the infirm elderly. In developed countries, including those in East Asia such as Japan, modernization has led to the care of oldest elderly being displaced from within households and families to the formal care sector. Such formal care can be provided by social services of various kinds but invariably a significant role is played by the medical system. The extent to which this occurs depends on the state of development of the medical and social services sectors, and policy regarding how the dependent elderly are cared for. When the choice of sector exists, policies and trends that affect the location of care can have a significant impact on the apparent level of medical spending. This is largely a matter of definition, since most definitions of medical spending have excluded the care of the dependent elderly by social services, but introduces an important variable into the discussion of the impact of ageing on future health care spending. In developed countries, where this issue is most recognized and where care systems for the elderly are most evolved, policies concerning long-term care and nursing care for the elderly can have a large impact on aggregate health spending. Either they can influence whether more expensive or less expensive modes of medical care are used (e.g. acute hospital beds versus long-term nursing home care beds), or whether care of the elderly is managed using medical means or not. For developed countries, this is increasingly the major issue in discussions of the future impact of ageing on aggregate health spending. However, in developing countries, the debate has only started in a few countries, reflecting the smaller numbers of elderly in these countries, and the lack of appreciation by policymakers that families are unlikely to continue to bear the burden of caring for the frail and dependent elderly.

3. HEALTH CARE EXPENDITURE PROJECTION METHODS

3.1 Overview of approaches used to project health expenditures

Increasing fiscal pressures caused by growth in public health expenditures and growing awareness of the ageing of the population has resulted in considerable interest in forecasting and projecting future health spending in developed countries since the 1970s. For the most part, and with few exceptions (Jamison *et al.*, 1984), such interest is relatively more recent in developing countries. A concern with the pressure on public budgets of health spending in the context of the inflationary conditions following the oil price crises of the early 1970s was the principle motivation behind the decision of OECD member countries in the 1970s to mandate the OECD secretariat to systematically assess and track the growth in health care spending in OECD member states. This led the OECD secretariat to begin to compile and report, on an annual basis, levels of health expenditures and other health system data for OECD countries. These data, which comprise the OECD Health Data database, as well as the national health accounts time series produced by the US government since the 1960s, have provided a rich and critical resource for those examining the determinants of trends in health care spending, including the impact of ageing. Without data on the actual trend in health care spending, it would be almost impossible to analyze what is driving health spending.

Almost all the work (more than 90 percent) that has been done globally on developing projections of aggregate health care spending has been in developed countries. This reflects not only the greater degree of policy interest in the issue, but also the abundance of data. Work in developing countries has been quite limited, and continues to be handicapped by the lack of necessary data to make robust projections. This section will review the methods and studies that have been reported in the literature. As will be seen, many of the methods in use cannot currently be used in developing countries owing to lack of data, and very few can be used in even a small number of developing countries. Nevertheless, the studies that have been done in both developed and developing countries provide clear indications of what impacts ageing might have on future health care spending and resource requirements in developing countries, and also where attention is required in future to improve the basis for making projections in developing countries.

As discussed earlier, the relationship between ageing and aggregate health spending is a complex one. It is also one that we lack full understanding of. The ideal projection approach would take into account all the factors that influence health spending and incorporate a framework that reflects the complexity of the underlying dynamics. Its projections should not only be reliable, they should also permit decomposition of any changes in future spending into attributable factors in order to support policy analysis.

However, fully specified models are not possible, and so developing a projection of spending is essentially an exercise in simplifying the known complexities (ignoring the unknown parts) into a methodology that incorporates some of them. In practice, simplification is also required to ensure that we use methods that are feasible to compute, as well as practical with the data that are available.

A number of approaches have been used to project expenditures. Some have been chiefly for the purposes of academic research and others have been for planning purposes. The methods used have varied and reflect differences in the objectives and questions being asked, the expertise of those undertaking the work and the availability of data.

Broadly speaking, the methods used can be categorized into four general approaches as follows:

(i) Econometric time-series analysis
(ii) Macroeconomic general equilibrium models
(iii) Epidemiological models
(iv) Actuarial models

3.2 Econometric time-series analysis

This approach uses econometric regression analysis to fit statistical models to time-series data of aggregate health expenditures. Having estimated such models, projections are made by using the model to predict future expenditures based on the projected values of the critical explanatory variables. In such models, the dependent variable is health expenditure (either as aggregate total, or per capita or as percentage of GDP), whilst various explanatory factors are included such as GDP, population, or inflation. In some examples of this approach, binary variables can also be included to account for discrete policy or health system changes. These models can be estimated for single countries or for groups of countries. Examples of multi-country studies from the OECD include Getzen and Poullier (1992), Gerdtham *et al*. (1992) and Barros (1998), and Gerdtham and Jönsson (Gerdtham and Jönsson, 2000) who provide a useful overview of the literature. This review located only one example involving developing countries, by Jamison *et al.* (1984).

This major constraint to this approach is its requirement for reliable time-series data on health expenditures. Fitting such models depends on having both reliable data and sufficiently long time-series. In practice, this restricts the method to a few individual OECD countries with long time-series of national health expenditure estimates (e.g. USA, Australia, Japan, Canada), or to grouped analyses using OECD Health Data. Even in the case of OECD countries, lack of reliability in available estimates for many countries continues to pose problems (Gerdtham and Jönsson, 2000). This data constraint severely limits application of this approach to developing countries. Far fewer than a dozen developing countries have time-series of national health expenditures of any significant length, China (20+ years), Philippines (15+ years) and Sri Lanka (12+ years) being among a handful of examples. Moreover, in developing countries, out-of-pocket expenditures account for a much larger share of overall national spending than is the case in OECD countries, and since estimation of out-of-pocket expenditures remains an imprecise exercise, the degree of measurement error in the available time-series data for non-OECD countries is much more substantial than for OECD countries, such as the USA and Australia.

Leaving aside the issue of data constraints, this approach does not lend itself to meaningful and detailed analysis of the impact of future ageing on health spending. For the most part, ageing, if it is included in such analyses, appears in the form of simple variables, which are included as potential explanatory variables, such as the percentage of the population aged 65 years or more. This does not lend itself to detailed analysis or unpacking of the role of ageing in expenditure trends.

3.3 Macroeconomic general equilibrium models

There are only a limited number of examples of this type of approach, which involves extending methods of analysis primarily used for analyzing macroeconomic growth. They have generally been used for the purpose of projecting health spending in a way that allows for exploration of the interaction of the health sector with the rest of the general economy. They proceed by specifying a model of the economy that consists of, at its simplest, two productive sectors – the health sector and the rest of the economy. Each sector uses a set of specified factor inputs, typically including labor and capital, to produce its own output, and the levels of inputs and outputs in each sector are set so as to achieve an economic equilibrium and overall macroeconomic consistency. Demographic change, including ageing, can enter these models via its implications for labour supply and demand for health services.

Warshawsky (1994) was the first to compare this approach with the more widely used actuarial approach discussed below. His macroeconomic model and subsequent elaboration (Warshawsky, 1999) produced results comparable to that from the actuarial approach, but helped to shed light on important implications of health sector growth for overall economic growth in the USA, via its impacts on the demand for capital and labor. The approach has also been used in multi-country studies to examine the long-term economic implications of ageing, via its impact on demand for health care services and public health expenditures (Martins *et al.*, 2005). Nevertheless, these models are not so useful for examining specific health sector questions. They operate at a level of aggregation that does not allow for detailed consideration of the multiple factors that drive health care spending, or for disaggregation of health spending into its many components. More specifically, they do not generally allow for analysis of detailed changes in age structure.

Whilst this approach is important in providing an additional perspective on health sector growth, its suitability and relevance for analyzing the impact of ageing in developing countries is limited (Mahal and Berman, 2001). Firstly, the questions for which it is most useful are not relevant in most countries, and certainly not in all developing countries. The share of the health sector in their overall economic output is much less than in the USA, and the impact of the health sector on economic growth is not usually a policy concern. Secondly, the limited use of the method and the difficulty in clearly explaining the workings of these models to policy-makers, especially health sector managers, militate against their use to examine health policy issues such as the impact of ageing on health spending. Thirdly, its requirement for a minimum level of economic expertise to construct the necessary models does not make it suitable for widespread use in developing countries outside an academic setting.

3.4 Epidemiological models

This approach involves projecting health expenditures as a function of forecast epidemiological trends. It depends on being able to link current utilization and expenditure for medical services with specific diseases and/or morbidity conditions. The incidence of these diseases or morbidity conditions are then projected forwards, and expenditures are then predicted on the basis of their current relationship with diseases or conditions.

In general, these models assume the following type of relationship:

$$H(t) = \sum_{i,j} N_i(t).D_{i,j}(t).U_{i,j}.P_i(t) \qquad (5)$$

where $H(t)$ is aggregate health spending in period t; $N_i(t)$ is the number of people in age group i in period t; $D_{i,j}(t)$ is the incidence of disease or morbidity condition j in age group i in period t, $U_{i,j}(t)$ is the average quantity of health care services per capita used by persons in age group *i* and living in condition *j*; and $P_i(t)$ is the average unit price of health care services consumed by persons in age group *i*.

The main feature of the epidemiological approach is that it goes beyond simply treating expenditures as a function of age-structure and it allows changes in the prevalence of disease or morbidity to enter as independent cost drivers, although they may be closely linked to changes in age-structure. In some cases, the age-structure of the population does not enter the models explicitly, but does so implicitly through the assumptions made in projecting future disease incidence.

For example, Baran (1995) projects future expenditure for hospital services in Poland using a model that incorporates age-structure, place of residence, and five major categories of disease (circulatory disease, neoplasms, injuries, poisoning and tuberculosis). The cost of health care is treated as a direct function of the demand for health services which is driven by changes in the included variables. A number of different scenarios for the future prevalence of disease were investigated, but a key finding of the model was that increases in circulatory disease incidence were likely to have a much larger impact on overall hospital spending than forecast demographic changes.

A more elaborate example of this method was used to forecast the future impact of non-communicable diseases on hospital spending in Chile (World Bank, 1995). The Chilean analysis involved using a Markov chain model to simulate the numbers of persons in the population living in and transferring between specific risk factor states according to projections of the levels of specific risk factors, such as hyperlipidemia, hypertension and smoking. Mortality and use of hospital care was then modeled as a function of the numbers in each risk state and other factors. The use of hospital care was predicted in terms of bed days, and hospital costs were then derived by multiplying the number of bed days by the average cost per bed day, based on current unit costs. The key finding of this analysis was that hospital costs would increase substantially because of the increases in risk factor prevalence.

As these two examples illustrate, this approach is useful in that it can highlight the way in which ageing affects future spending through its impact on the composition of demand for medical services. However, the approach suffers from a number of disadvantages, which have negative implications for its use for projecting aggregate national health care costs. Firstly, it depends on the ability to make meaningful forecasts of future epidemiological trends. In practice, this is not easy, since it is technically demanding and data intensive to do well, and can usually only be done for a limited range of conditions. In both the studies mentioned, the analysis was restricted to major conditions resulting in hospitalization. In practice, the literature does not provide much evidence to indicate that we have adequate methods or knowledge to accurately predict the future course of epidemiological trends. The evidence in recent years is that technological developments can substantially alter beyond previous expectations the impact of specific diseases, even one as well-described as ischemic heart disease. Secondly, the approach by itself does not take into account other drivers of costs, such as changes in technology, prices or unit costs. As the evidence indicates, these other factors are in fact more important drivers of costs.

3.5 Actuarial models

Actuarial approaches to all work by projecting health spending as a function of (i) the number of people in specific age (and sex) groups, and (ii) the expenditure per person in each age group. At their simplest, they assume the following relationship:

$$H(t) = \sum N_i(t) E_i(t) \qquad (6)$$

where *H(t)* is aggregate health spending in period *t*; $N_i(t)$ is the number of people in age group *i* in period *t*, and $E_i(t)$ is the average expenditure for health care per capita used by persons in age group *i* in period *t*. The number of people in age group, $N_i(t)$, is typically obtained from available population projections, and $E_i(t)$ requires data on the current profile of health spending by age-group.

The model described in equation (6) is very basic and in actual practice, almost all actuarial projections elaborate on this. A simple extension is to recognize that the intensity of health care spending may be changing and to allow $E_i(t)$ to vary over time. An example of this is a study by Fuchs (1998), which projects US health care spending by assuming differential rates of growth in age-specific health expenditures and overall increases in age-specific per capita spending. There appear to be no examples of published studies from developing countries that limit themselves to this approach.

In practice, most studies adopt one or more of the following additional features:

(i) Expenditure for health care in a particular age group, $E_i(t)$, can be decomposed into its constituent elements of utilization and price (or unit cost), each of which is separately projected, assuming different annual rates of change. This directly corresponds to the relationship presented in equation (1).

(ii) The population within an age and sex group, $N_i(t)$, can be further differentiated into different health status or disability conditions.

(iii) Health care spending itself, *H(t)*, can be further differentiated into categories corresponding to different types of services, each with its own characteristic profile of spending levels and demographic use patterns.

It is noted that as these elements are successively included in the actuarial approach, the underlying model more closely resembles the framework presented in section 2.3. In fact, the actuarial approach has proved to be far more relevant and superior to other methods in understanding the impact of the known cost drivers on the future cost of ageing. This, and its flexibility, makes it the most useful, and probably the most reliable of the four main projection methods.

Once a model has decomposed expenditure into utilization and price components, each of these components can be forecast separately. In the case of utilization, this is a case of projecting future rates of utilization of health care services. In the case of the price (or unit cost), this involves forecasting future inflation in medical care prices (or productivity change in public sector services). Inflation can be projected either in absolute terms, or it can also be decomposed into a component consisting of general economy-wide price inflation and a component corresponding to health sector-specific price inflation. To make such projections of utilization, price and costs, analysts can either rely on historical trend analysis, or on more complex explanatory models of the relevant variables.

If historical trend analysis is used to predict the future trend in explanatory variables, typically an error term is added to the model (Arnett *et al.*, 1986; Harvard Team, 2000). This is because the explanatory variables used usually do not fully capture the forces driving the historical trend in expenditures, and because of potential measurement errors. The error term is added to the explanatory variables in the analysis to ensure that there is an identity in the relationship between aggregate health spending and the independent explanatory variables being included (Mahal and Berman, 2001).

The method of using behavioral or economic models to predict future trends in key variables is less commonly used, because it depends on having access to significantly more data, as well as well-developed microeconomic models. The latter is in fact quite difficult, as models of health care seeking behavior by patients or price-setting by providers that would be robust enough to make reliable projections require considerable technical sophistication, as well as many years of experience to assess their reliability. This is illustrated by the experience in the USA, where the actuarial approach has long been used to project national health spending but where historical trend analysis was the main method of analysis until recently (Freeland and Schendler, 1981; Arnett *et al.*, 1986; Sonnefeld, 1991; Technical Review Panel on the Medicare Trustees Reports, 2000). It is only in the past decade with the maturation of a number of critical microeconomic models of the health care market that US government analysts have begun to incorporate microeconomic models to predict key variables in their actuarial projections (Technical Review Panel, 2004; Office of the Actuary, 2006). Application of the newer methods now used by US analysts will not be feasible in developing countries, which lack the considerable research literature on health care markets available for the USA.

In terms of differentiating the various elements of utilization, price (or cost) and population in the basic model corresponding to equation (1), there are many different examples in the literature, as summarized below.

Changes in health care utilization

Many studies distinguish between different types of health care service and utilization. The most common is to distinguish between inpatient and outpatient use, and examples of this include projections of health care spending in the USA (Technical Review Panel on the Medicare Trustees Reports, 2000), the UK (Wanless, 2002), Hong Kong (Harvard Team, 2000; Department of Community Medicine and School of Public Health, 2005), Thailand (Ogawa, Poapongsakorn, and Mason, 1988), Malaysia (Ogawa, 1985), Japan (Ogawa, 2003) and Sri Lanka (Rannan-Eliya, 2005). It is also possible to go further than this by then distinguishing inpatient utilization by types of care, such as differentiating between acute and chronic admissions, or between specialist and general practitioner care. The most elaborate demonstration of this is the methodology used for the projections of the US Medicare program.

In general, this more refined treatment of utilization is eminently feasible in many developing countries, where estimates of the age-sex utilization rates for inpatient and outpatient care can readily be obtained by analysis of household survey data and health care facility statistics. However, few studies outside the OECD region have attempted to incorporate changes also in the rate of age-sex specific utilization. This requires a recognition that utilization levels are in fact changing over time (typically upwards), which most analysts fail to appreciate. The analysis itself is relatively straightforward, as it only requires the estimation of historical trend data in age-sex specific rates of utilization. There are some examples of this being done, including studies from Sri Lanka (Rannan-Eliya, 2005), Hong Kong (Department of Community Medicine and School of Public Health, 2005), and Thailand (Ogawa, Poapongsakorn, and Mason, 1988). The fact that when this has been specifically investigated analysts have found evidence for increasing age-sex specific rates of medical care use in both developed and developing countries, typically, parallel to improving health status, highlights an important issue. In most of these studies, changes in the propensity of people to use health care has a far larger impact on overall health care demand than the simple effects of ageing on the population structure. The implication is that projection methods that fail to incorporate trend analysis of changes in health seeking behavior are likely to overestimate the relative impact of ageing on health spending in comparison to other factors.

Medical price inflation and productivity change

It should be noted that there are two parts to price changes in the health sector. The first is that which is related to changes in the general price level in the economy, that is, general inflation. The second is that part of the change in prices which is specific to the health sector or a particular medical service, which is additional to general inflation. From a policy perspective, general inflation is largely irrelevant, since a change in prices in the health sector that is no different to that in the rest of the economy has no implications for the overall share of national income devoted to health spending. However, changes in health sector-specific prices can be very important, not only because they can have a substantial impact on the real level of health care spending, but also because they may be subject to control by health sector policy-makers.

Most studies that have explicitly incorporated the impact of changes in the unit price or cost of medical services have concluded that this plays a major role in driving trends in health care spending. In fact, in the USA, it is thought to be the most important driver of health care costs (Reinhardt, 2003; Anderson *et al.*, 2003). In public sector systems, productivity change has frequently been found to have as large an impact on future health care costs as ageing itself (Rannan-Eliya, 2005; Wanless, 2002).

As has just been suggested, price change in the medical sector presents in two forms. The first is changes in the prices of medical services and goods sold in the market by providers. The second is changes in the unit cost of services delivered by the public sector at no charge or at highly subsidized prices. The first is usually termed medical price inflation, and the second is what is normally termed productivity change, since an increase in the unit cost of producing a service is the equivalent of a reduction in productivity, and visa-versa. Both these elements have been infrequently incorporated in projections of health care spending. The major reasons for this have been the lack of reliable data, and lack of awareness of their importance in explaining spending trends. In the case of medical price inflation, data are required on changes in the average price of a representative range of medical services and goods. Although many countries collect data on a set of such goods and services as part of their normal efforts to estimate general price inflation, typically the range is too small to be truly representative of prices in the health sector or the data are not reliable enough for this purpose (Berndt *et al.*, 2000). Whilst the US and many developed countries have invested considerable resources in recent years to improve compilation of medical price indices, reliable medical price indices are not generally available in developing countries. However, in countries which have reliable health accounts time series, it may be possible to estimate long-term price trends by combining data on private expenditures and utilization data.

Productivity change is the other type of price change. If the sector can produce a medical service with fewer inputs or at lower cost, this will be reflected in reduced unit prices or costs, and is a productivity improvement. Measurement of health service productivity change presents a number of technical problems, but several studies indicate that in the countries where it has been examined, it can be of the order of 1-4 percent per annum (Rannan-Eliya, 2004; Sintonen and Linnosmaa, 2000). An effect of this size is, in fact, large enough to have a substantial impact, since most studies report that the pure effect of ageing is typically less than 1-2 percent per annum. When productivity change has been recognized as a factor in its own right, several studies from developed economies have found that increasing health service productivity can substantially mitigate (or even reverse) the impact of ageing on future health care costs (Wanless, 2002; Department of Community Medicine and School of Public Health, 2005), and this has also been reported by the one developing country study on the topic (Rannan-Eliya, 2005).

Unfortunately, the issue of health service productivity change continues to receive inadequate attention from economists and health planners, especially in developing countries, so productivity change is rarely measured. Much more effort needs to be made to ensure that future studies projecting health spending in developing countries take this issue into account. It may require that such studies develop measures of productivity change themselves. This is often feasible, as crude measures of productivity change can be derived if time series data exist for public sector health expenditures and for levels of output of services produced by the public sector. The study of Sri Lanka by Rannan-Eliya (2005) shows how this can be done.

Health status

The basic actuarial model represented by equation (6) assumes that health expenditures are the same for all individuals in a given age and sex group, that is, that $E_i(t)$ is the same for all individuals in group i. This assumption can be improved upon by recognizing that health spending is correlated with the health status of the individual. Persons who are chronically sick, disabled or suffer from certain disease conditions typically use more medical services and are associated with higher levels of health spending. By itself, the fact that different individuals have different levels of health spending does not have any implications for predicting future health care spending, since we are essentially concerned with the average level of spending. If the frequencies of states or conditions that variations in health spending are associated with are themselves subject to change over time and are amenable to prediction or projection, then incorporation of such states into the actuarial model may be advantageous. However, incorporation of all such states may not always be practical, as experience also shows that beyond a certain point, results become less reliable and robust the more categories and variables that are added. How many discrete different states are then added may thus be a matter of empirical judgment about the trade-offs involved, assuming the relevant data are available.

There are a number of examples illustrating how health status or conditions can be incorporated into projections of health care spending. The recent study of the impact of ageing on future health care spending in New Zealand adopts an actuarial model approach, and subdivides the population in each age group into three, according to disability state (Ministry of Health, 2004). Each of the disability states are modeled separately, and are associated with different levels of health spending per capita. Monteverde (2005) estimates the future cost of long-term care (LTC) provision in Spain, and incorporates in the method different levels of disability as measured using ADLs. Data on the distribution of disability were obtained from two disability prevalence surveys, and disability levels were then projected into the future. A similar approach is presented for the USA by Goldman *et al.* (2005), who project health care spending for Medicare beneficiaries using a model which allows health care spending to vary according to functional status. Other examples include studies from Israel (Chernichovsky and Markowitz, 2004) and the UK (Wanless, 2002).

Unfortunately, there appear to be no studies from developing countries that have incorporated health status as an independent cost driver in making cost projections. Other than lack of awareness, the major barrier to incorporating health status in such work is likely to be lack of data. To do so requires information not only on the variation of health spending (both public and private) by health status, but also sufficient information to be able to project future trends in health status by age group. The first is difficult, though not impossible to estimate, and the second would require cross-sectional data on disability or health status distribution collected at two different points in time sufficiently far apart. The latter may be available in future for a few developing countries. A high priority for future work in developing countries should be to measure the relationship between chronic ill-health and disability status and health spending, and to better define the trend in age-specific prevalence of such states over time.

Proximity to death

Proximity to death is an extension of the use of health status in projection models. It has been known for many years that health expenditures are much higher than average in the last year of the average person's life as noted earlier and this has been empirically confirmed in a large number of mostly developed countries where it has been possible to examine it. If the hypothesis of compression of morbidity is correct, this concentration of expenditures implies that ageing will push a large fraction of expenditures later into life, and that much of the observed increase in per capita expenditures with age is simply due to the higher incidence of death in higher age groups. There is some evidence for this, and several studies have now incorporated this idea into cost projections by dividing the population into those who are survivors and those who die in a particular year. Doing so generally diminishes the impact of ageing on future health care spending. Such analyses now exist for several countries, including New Zealand (Ministry of Health, 2004), Switzerland (Zweifel, Felder, and Meiers, 1999), UK (Wanless, 2002) and USA (Cutler and Sheiner, 1998).

There appear to be no studies in developing countries that have incorporated proximity to death in projections of future health care spending. This is consistent with the general lack of evidence on the compression of morbidity hypothesis in those countries. It is generally difficult to measure the concentration of expenditures at end of life since, in the typical developing country there are no databases enabling researchers to reliably examine all health care use by individuals in a given year. Even in a developing country where most hospital admissions take place in the public sector, it is still not possible to obtain data on admissions by specific individuals, since such health care use is not recorded on that basis. However, the feasibility of doing this is changing as more developing countries introduce universal health insurance schemes and begin to collect electronic data on health care use by individuals.

3.6 Long-term care

In recent years, there has been increasing interest in modeling the impact of ageing on long-term care expenditures and social care for the elderly expenditures. Much of this can be seen as an extension of the research on the impact of ageing on health care spending. Examples include expenditure projections for Spain (Monteverde, 2005), USA (Goldman *et al.*, 2005) and several OECD countries (Jacobzone *et al.*, 1998).

Such studies have been conducted only in developed countries, and reflect two trends in these countries. The first is the more advanced state of population ageing in these countries, which are beginning to confront the issues arising from having large numbers of the population in the very elderly age groups (80+ years), where the likelihood increases exponentially of being classified as frail dependent elderly. The second is that, in the developed world, where health care financing arrangements are already universal in almost all countries, the policy agenda is progressing further to deal with the issue of how long-term care for the elderly should be financed. In several countries, notably Japan and Germany, social health insurance programs have been expanded in the past decade to finance long-term care, and in other developed countries, public financing is increasingly used to pay for long-term care provision for those who are in need of it. With the development of these programs, governments have increasingly worried about the long-term fiscal cost of such provision, stimulating new research into modeling future long-term care expenditures. Although these trends may seem irrelevant to the bulk of the developing world, it would be reasonable to anticipate that these same policy issues and debates will eventually surface in the developing world, starting first with the middle-income developing countries. The issues that have arisen in developed countries are thus an indicator of the issues in future for developing country policy-makers.

The technical problem of modeling long-term care is actually not too dissimilar to that of modeling other health care spending, so it does not in itself present any new challenges. However, as work has expanded in this area, a number of issues have been confronted. The most important are the substitution of formal long-term nursing care provision for traditional medical care provision and the measurement of long-term care expenditures. In a sense both of these are inter-related.

In pre-modern societies, the frail, dependent, and elderly were generally looked after by their families, neighbors and local communities. With modernization, and the increase in the ratio of the numbers of the very elderly to those in the younger adult age groups, these informal arrangements tend to be replaced by formal arrangements. Typically, part of this process in Europe, Japan and other developed countries has been the implicit reliance on the formal medical sector to look after the frail elderly. For example, this has seen an increasing share of acute hospital care services in many developed countries devoted to caring for the dependent elderly, who are not suffering from acute illnesses requiring treatment. Of course, with time, societies have developed other mechanisms of formal support that are less medicalized, including formal social support services and long-term nursing care. This increasingly means that countries have a choice of mechanisms for looking after the frail, dependent elderly who need care with some element of medical management. They can use existing acute or chronic hospital services or other medical alternatives such as day care, or other community-based options, such as long-term nursing care institutions or community-based nursing support services for the elderly who continue to reside in individual homes. This transformation of the way in which the dependent elderly are managed has begun to blur the boundary between the medical and social care sectors. This, in turn, has made it more complicated to answer the question of what impact ageing has on the health sector, since it requires clarity on what constitutes health care services. Analysis of expenditure trends confronts a similar problem of defining the boundary of what constitutes health expenditure, and how to measure other social care expenditures.

The realization that some medical care can, in fact, be substituted by less medicalized forms of social support raises the important question as to whether such expenditures on less medically-intensive forms of social provision should be isolated from the problem of estimating the impact of ageing on health expenditures. For example, in several developed countries, changes in social policy in the past two decades have resulted in apparent sudden changes in reported health spending, although no major organizational changes had occurred. In some instances, official policy decided to demedicalize certain forms of institutional care for the elderly by transferring responsibility from the health sector to the social sector, leading to decisions to stop counting the institutional care expenditures as health spending. In other cases, such as Japan, the decision to introduce formal financing arrangements for long-term care results in an increase in reported expenditures as care is shifted from informal and statistically unmeasured arrangements to formal sector arrangements.

These trends posed the problem of defining clearly the boundaries of what constitutes health expenditure, and categorizing in a consistent and internationally-comparable manner health and health-related expenditures for the frail, dependent and elderly, so that these can be monitored and projected. Fortunately, much work has recently gone into addressing these problems. Firstly, the OECD in its proposals for standardized health expenditure measurement (OECD, 2000), which have now been endorsed by WHO (World Health Organization, 2003), explicitly defined two categories of expenditure for long-term nursing care and day care in the ICHA classification of functions of health care spending. OECD and European countries are now beginning to systematically measure and report these types of spending, including undertaking the development of improved methodologies for measurement (OECD, 2005). Secondly, both the OECD and European Union research centers have begun to undertake work on tracking these new ageing-related expenditures, and to develop methodologies for projecting them in future years.

At the current time, it must be reported that no such work to better measure such health and social expenditures is being undertaken in developing countries, and currently, there appear to be no comparable efforts to undertake collaborative multi-country research work in this area.

3.7 The use and limitations of expenditure projection models

Planning versus forecasting

It is important to emphasize that there are two different purposes that projection models can be used for. Models can be used either to analyze the potential impact of different policy choices on future spending, or to predict what the actual level of spending will be in the future. The first use involves examining what might happen under different scenarios of policy choices or different environmental trends, in order to evaluate the options. The second attempts to predict as accurately as possible future spending, assuming that current trends continue.

The first type of use involves the use of projection models as **policy planning models**. In this type of analysis the parameters in the model are altered and the resulting expenditure projections examined in order to determine the implications of specific changes. These changes might be subject to policy choices or represent possible trends in environmental factors beyond policy control. The UK projections developed by Wanless (2002) illustrate both types of changes. They envisage three different scenarios, in each of which different combinations of government policy and natural trends are assumed. In one, there is rapid uptake by the health services of new technology (policy-determined variable) and positive change in individual health-seeking behavior (environmental factor). In another scenario, there is rapid uptake of technology and rapid productivity increases (policy-determined variables), and life expectancy and health care demand increases more than expected (environmental factors). By considering these different scenarios, Wanless was able to assess the potential ranges in costs that the government health services would face, as well as examine how policy itself could alter the future financial requirements. A different example of the use of this approach is the cost projection model developed by Fairbank *et al.* (2000) for Egypt. This software model incorporates a cross-sectional model of current health care costs and health-seeking behavior in the country, which then allows the user to project health expenditures based on different settings for policy-specific variables such as the level of co-payments for insured services, rules about who is entitled to insurance coverage, and changes in the cost of services. Although the model does not specifically incorporate demographic change, it could presumably be modified to do so, and provides a useful demonstration of the potential for scenario modeling for policy purposes.

The second type of use is in **forecasting models**, whose objective is to predict as accurately as possible future health spending. The main interest in this situation is not with analyzing the impact of different policies, but simply knowing what future spending is. Forecasting projections are most frequently wanted by funding agencies, such as social insurance funds, to assist with long-term financial planning and budgeting. The best example of this is probably the long-term forecasts made by the Medicare Trustees in the USA (Heffler *et al.*, 2005), whose forecasts are required by the US Congress because of the major implications of Medicare expenditure trends for fiscal policy.

Limitations

The main value of a cost projection for policy planning purposes is the insight it gives into the potential implications of different policy options, and the relative merits of each. For this purpose, prediction accuracy is generally not so critical, as long as the directions and sizes of different scenario trends are relatively correct. However, when projection models are used for forecasting purposes, the only valid evaluation criterion is accuracy, i.e., the difference between the forecast value and actual outcome. Unfortunately, it is uncommon for forecasting models to be evaluated for accuracy on a retrospective basis, which hampers our understanding of the reliability and accuracy of different methods. Such assessments are routine for forecasts of GDP, population, labor force and other similar exercises, but have rarely been conducted for health expenditure forecasts. One rare example of this is Hong Kong, where the most recent projections of future health spending made comparison with the projections made five years previously, finding some significant forecast errors (Department of Community Medicine and School of Public Health, 2005). The finding of such differences provides a useful reminder of the limitations of most models, and of the need for users to understand fully their limitations. Certainly, more evaluations are desirable and should be incorporated into forecasting work, as well as regular reviews of the forecasting methods, as does take place with the US Medicare projections (Technical Review Panel, 2004).

Other than the general uncertainty in making any forecast, the other major limitation of projections is that they inherently assume that the level of expenditures is autonomous and driven by forces beyond policy-makers control, other than specific policy interventions to change features of the health system. However, it is important to bear in mind that in many countries, the overall level of expenditures is very much an explicit policy choice. Where the government controls the bulk of financing, the aggregate level of expenditure at least in the short-term can be set simply by the budget choices that the government makes. Nevertheless, this is usually not the case in the long-term. If underlying cost pressures, which most models attempt to reflect, become too divergent from actual budgeting decisions, the political process in many countries will often exert a corrective brake or push on budgetary spending.

4. AGENDA FOR FUTURE RESEARCH

4.1 Key findings from existing studies

During the past twenty years, there has been a growing interest in exploring the impact of population ageing on future health care spending. Although most of these efforts would not claim to accurately predict the future course of spending, they have been extremely useful in helping to understand the potential implications of ageing trends and in grasping possible areas for intervention.

A number of different approaches have been used to project future health spending, and to explore the impact of ageing on this. Of the methods used, the most widely accepted is the actuarial approach. This approach is not only used to generate official cost projections in most developed countries which make such projections, it also has a number of advantages over other methods. These are:

(i) Simple actuarial approaches have proven the most reliable and feasible of the major methods used for forecasting (Technical Review Panel on the Medicare Trustees Reports, 2000). Improvements involve use of more complex microeconomic modeling techniques and require considerably more data than are available in most developed countries (Technical Review Panel, 2004; Office of the Actuary, 2006). These remain practical only in a few developed countries such as the USA.

(ii) The basic actuarial model does require a minimum amount of information, but in practice the data requirements are less extensive and can be met in more countries, both developed and developing, than is the case for the chief alternatives such as epidemiological or econometric time-series analysis methods.

(iii) The structure of the typical actuarial model most closely corresponds to our current understanding of how ageing might impact health care spending. This means that the approach is much better able to generate information and insights on how changes in different factors may affect future resource requirements. Because these factors can be explicitly modeled in the actuarial approach, it is possible in these studies to determine the relative impact of each of the factors on future costs.

(iv) Studies using the actuarial approach have been able to capture the largest range of cost drivers. This has been important, as these studies have repeatedly confirmed that ageing itself is only one of many factors that will influence future costs.

Although the actuarial approach has not been widely used in developing countries, several studies have demonstrated its feasibility and applicability in these settings (Ogawa, Poapongsakorn, and Mason, 1988; Rannan-Eliya, 2005). For the reasons of feasibility and policy interpretation, it remains the best available method for projecting future health care costs in developing countries. Methods using the actuarial approach need to be more widely demonstrated and used in developing countries.

When actuarial projections have incorporated, a wide range of factors as potential cost drivers, they have tended to produce a number of important conclusions:

(i) The pure effect of ageing – the change in the age structure of the population – on future health care costs is commonly found to be 0.5-2.0 percent per annum in countries that are relatively advanced in the demographic transition, i.e. given their anticipated demographic trends over the next half a century or so, health expenditures in these countries will increase at this rate per annum as a result of ageing alone.

(ii) Population ageing is almost universally overestimated in terms of importance relative to other factors.
(iii) Price inflation, productivity change and changes in health-seeking behavior of patients typically have much larger impacts on the level of future health care spending than ageing itself, and can substantially mitigate the impact of ageing.
(iv) The extent to which morbidity is compressed and leads to concentration of health spending in the last years of life has a significant implication for the impact of ageing on future costs. If concentration occurs to a significant extent it will tend to substantially reduce the long-term impact of ageing on future health spending.
(v) If morbidity is compressed with ageing and leads to increases in health life expectancy, this will have a substantial negative effect on future health care costs, which will offset much of the positive impact of ageing.
(vi) Technological change in the medical sector is contributing to increased life expectancy and ageing, but it also contributes significantly to increased costs. Policies that reduce the introduction of cost-increasing technologies will result in lower growth in future health spending.

As the work to projected health spending has gained maturity, researchers and policy-makers in developed countries increasingly confront the issue of how to deal with the increase in formal expenditures for social care and long-term nursing care for the frail, dependent and elderly. Whilst expenditure projection methods can easily be extended to include these, efforts are still required to improve current measurement methodologies. More importantly, it is becoming evident that from a policy perspective it is necessary to project both health and long-term care expenditures in order to fully understand the impacts of ageing on future social and fiscal costs. These lessons will be relevant in future to developing countries.

4.2 Issues specific to developing countries

With fewer than a dozen exceptions, all work to date on projecting the impact of ageing on future health and social care expenditures has been restricted to developed countries. The few studies that have been carried out on developing countries have tended to be relatively unsophisticated, and have usually failed to incorporate lessons from methodological advances made in developed countries.

However, many developing countries will face the same processes of ageing that the developed countries are currently experiencing at a much faster speed. It is thus important that developing countries develop a better understanding of the cost implications for their health services of ageing. At the same time, it is clear that the current policy debates on these issues in developing countries have tended to underestimate the importance of factors other than ageing on future health care spending. This reflects the lack of application of more sophisticated approaches to thinking about the impact of ageing on costs. Research to better define and model the impact of ageing on future spending needs is thus desirable, not only to generate more reliable information for planning purposes but, more importantly, to stimulate more informed debate.

If work in this area is to be expanded in developing countries, there clearly exists a number of important gaps that should be addressed. These consist of areas for methodological improvement and significant knowledge gaps.

Areas for methodological improvement

1. In the near term, future work in developing countries should focus on use of the actuarial approach for modeling future health spending.
2. Actuarial modeling in developing countries needs to include a wider range of cost drivers, in particular, productivity change, medical price inflation and changes in the propensity of people to demand medical care.
3. Actuarial modeling in developing countries should move towards incorporating proximity to death and changes in morbidity associated with morbidity compression as evidence on these issues becomes more available.
4. Unlike in developed countries, no work in developing countries in this area has been conducted on a multi-country collaborative basis. Such an approach is important as it provides a stronger basis for generalizing results, and for ensuring comparability of findings.
5. Projections of future health care spending in most OECD countries benefit from work to improve the methods for estimating national health expenditures and their systematic reporting. Significant efforts need to be made in developing countries to improve the measurement of national health expenditures, as without such information it is impossible to project future expenditures. This implies continued efforts to improve national health accounting methods in developing countries, and to move towards regular estimation and reporting of expenditures.

Knowledge gaps

1. Work in developed countries has substantiated the notion that compression of morbidity is leading to increases in healthy life expectancy and thus mitigating the impact of ageing on future health care costs. However, there is no empirical evidence on this issue in developing countries, so it is impossible currently to know whether it will have similar implications for developing countries. Research to look for evidence of morbidity compression in developing countries should be a high priority for any global research agenda.
2. The concentration of health spending in the last years of life has not been well documented in developing countries. Owing to its importance in projecting future health spending, efforts should be made to examine existing data to investigate this in developing countries, as well as to plan prospective studies to collect such data.
3. There is a general lack of information and research on productivity change in health services in developing countries. Given its potential impact on future costs, and that this is an area potentially amenable to policy intervention, there should be significant research on this topic. The goals should be to develop more feasible methods for measuring productivity change in developing country health services, and also measuring such changes in selected countries with potential data.
4. The lack of data on what proportion of national health spending is for the elderly is perhaps a more important priority knowledge gap to be addressed than projecting such elements of spending. Those agencies and experts working on compiling health expenditure accounts for developing countries should be encouraged to extend such work to look at the age distribution of spending, so that we obtain a better understanding of how current expenditure profiles relate to the age structure of populations in developing countries.

4.3 Current research efforts and activities

As has been noted frequently in this paper, most of the research on the impact of ageing on future health care costs is being conducted in developed countries. This work has been undertaken both within countries and also at a multilateral level. Such work typically is of four types, as discussed below.

Routine official projection exercises

Currently only a few developed countries routinely model and project national health care spending. This is often undertaken as input into the management of national health insurance programs. Examples include the annual projection of national health expenditures in the USA by Medicare analysts (Office of the Actuary, 2006), and similar efforts in a number of European countries. Typically, this work is undertaken by government statisticians and analysts.

Ad-hoc official studies

Most of these are conducted in developed countries, and are typically motivated by concerns about the impact of ageing on public budgets, or are initiated as part of strategic reviews of health financing. Current and recent examples include studies commissioned by the Government of Hong Kong SAR (Department of Community Medicine and School of Public Health, 2005), work initiated by the Australian government (Productivity Commission, 2005), and a recent call for proposals on the topic by the Irish Health Research Board. There have also been a few instances where such studies have been commissioned by developing country governments, notably Sri Lanka (Rannan-Eliya, 2005). The general experience has been that governments that have undertaken such studies often find them so useful that they decide to commission subsequent updates; examples of this include the UK and Hong Kong.

Academic research studies

There is growing interest by researchers in the issue of ageing, and a corresponding increase in academic studies of the topic. Almost all of these studies are carried out in developed countries, by far the most of which are conducted in the USA. Although this research can adopt a wide range of methods, it has proven useful in developing new methods, enriching the literature, and also highlighting important issues that have not been previously considered. A number of academic institutions and research centres maintain active research agendas in this area, mostly based in the USA, Japan and Europe.

Multi-country studies at the international level

Almost all the available multi-country investigations have been conducted or commissioned by the OECD and European Commission. Some work has also been done by the International Monetary Fund in this area, but it is too general in nature to be reviewed further here. Multi-country studies have been very important in exploring the general impacts of ageing, and identifying specific issues for future research. They have helped considerably in raising awareness of the issues in individual countries, and stimulating research at the national level. In addition, cross-country collaboration has often fostered networks of researchers interested in sustained work on the topic, and helped develop methodological improvements.

The OECD Secretariat continues to explore and study the impact of ageing on OECD societies and economies, and this generates on a regular basis studies of the impact of ageing on expenditures. At the European level, the European Commission is funding the AHEAD study, which is a multi-country collaborative study led by the Center for

European Policy Studies to develop methods and undertake projections of the impact of ageing on future health spending in EU states (see Appendix Table A.6). Also in Europe, a number of collaborative studies in European countries are being led by the European Centre for Social Welfare Policy and Research, based in Vienna, which is examining a number of issues, including forecasting future trends in long-term care spending. In the Asia-Pacific region, the recently established OECD Regional Center for Health and Social Policy (RCHSP), based in Seoul, is currently working to develop a collaborative research agenda to examine various aspects of ageing in developing countries in the region, and to share OECD experience in this field.

4.4 Future activities of WHO Kobe Centre

WHO does not have significant financial resources, and is not in a position to support a wide-ranging and substantial independent research effort in this area. Much of the basic field research that is required, for example longitudinal studies of disability and health status, require the kind of financial resources that only large foundations and national research funding bodies in OECD countries are in a position to provide. Nevertheless, there remains a serious dearth of research looking at these issues in the context of developing countries.

To maximize its impact, it is recommended that the future work of WHO Kobe Centre (WKC) include the following strategic objectives:

- To catalyze work in under-researched areas relevant to developing countries.
- To encourage the development of research collaboration in developing countries to parallel and work with similar networks already existing in developed countries.
- To stimulate increased levels of awareness of the issues amongst policy-makers globally so as to encourage increased investment in this field.

Recommendations

1. WKC should support a multi-country collaborative study to test and demonstrate the application of actuarial-based projection methods to analyze the impact of ageing on future health costs in a representative group of developing countries. The aims of this study would be to increase awareness of the issues raised by ageing, identify to what extent the problem varies around the world and is different to that in developed countries, and demonstrate the feasibility and limits of existing technical methods in the developing country context. Since the actuarial approach requires a minimum level of data on current expenditures and some modeling expertise, it is recommended that this study should select countries which have some national health accounts capacity and health services research expertise. Possible countries include China, Thailand, Sri Lanka, Malaysia, Iran, South Africa, Jamaica, Bolivia and Israel. Resource centres where experts have indicated potential interest in collaboration in such work include the OECD Regional Center for Health and Social Policy in Seoul, the European Centre for Social Welfare Policy and Research, Institute for Health Policy in Sri Lanka, and Ben Gurion University of the Negev in Israel.
2. WKC should identify and co-finance with other interested agencies exploratory research to determine whether available data in any developing countries can shed light on the existence or not of compression of morbidity, and to estimate the extent to which health expenditures are concentrated in the last year of life. Such research

might be undertaken in a small number of countries only, based on data availability. An end product of such research should be development of a research agenda and potential study designs to collect primary data to investigate these topics further.

Agencies that may be potentially interested or persuadable to co-finance this agenda include the OECD Regional Center for Health and Social Policy and the European Commission.

APPENDIX: SELECTED STUDIES INVOLVING PROJECTIONS OF HEALTH EXPENDITURES AS A FUNCTION OF DEMOGRAPHIC AGEING IN DEVELOPED AND DEVELOPING COUNTRIES

A.1: Econometric time series analyses

Country	Author(s)	Details	Projection period/Results
OECD countries	Martins *et al*. (2006)	Projection of public expenditures on long-term care and on health care (both preventive & acute), factoring in demographic and non-demographic variables separately. LTC expenditure projection using econometric model. Demographic drivers included in expenditure projections, with each age group split into dependants and non-dependants (assumed dependency ratios to be uniform across all countries). Non-demographic drivers included informal and formal care resource costs and prices and their evolution over time. A simple econometric model was used to assess the impact of these different drivers of LTC costs. Other than the main projection scenarios descried above, several alternative projection scenarios based on underlying assumptions were also evaluated for LTC: • Cost-pressure scenario – assumed LTC costs per dependant to increase in line with average labor productivity (full Baumol effect). • Unitary income elasticity – assumed income elasticity equal to one. • Compression of disability (healthy ageing) – assumed the prevalence of dependency per age is shifted by 1 year for every 10 years. • Expansion of disability – prevalence of dependency to remain constant over time. • Increase in dependency rates (assumed to increase by 0.5% per year) and participation rates of 50-64 years (to increase to	2005 – 2050 In the cost-pressure scenario average health and LTC spending across OECD countries is projected to almost double from 7% of GDP in 2005 to 13% by 2050. In the cost-containment scenario average expenditures to reach around 10% of GDP around 2050. Non-demographic factors (effects from technology and relative prices) identified to be the most important drivers of the increase in health care expenditures.

Country	Author(s)	Details	Projection period/Results
		at least 70% by 2050). Health care expenditures projected using actuarial approach. Various cost drivers included. Demographic drivers of expenditure included numbers of survivors and non-survivors. Costs for non-survivors estimated by multiplying costs of death by age group x the # of deaths per age group (assumed health costs are concentrated in the proximity to death – death related). Costs for survivors derived from the difference between the total cost and non-survivor costs. Non-demographic drivers for health care costs included income growth and an OECD average residual expenditure component (included advances in medical treatment/technology and assumed to grow at 1%). Other than the main projection scenarios descried above, several alternative projection scenarios based on underlying assumptions were also evaluated for health care costs: • Cost-pressure scenario – assumed the expenditure residual grows at 1% per year. • Income elasticity scenarios assumed to equal to 0.8 and 1.2. • Residual growth to equal to 1.5% in 2005 and to converge to 0 by 2050. • Compression of morbidity – longevity gains to double into additional years in good health (and no healthy ageing adjustment in the expansion of morbidity scenario).	
Canada	King *et al*. (2000)	An accounting model is used to project expenditures that are affected by demographic changes and projected as a function of population growth rate, inflation rate, spending growth due to compositional change within the population and the real per capita spending enrichment rate. The demographic composition variable is	2000 – 2040 Population aged 65 and over expected to increase from 12.6% in 2000 to 22.6% in 2040.

Country	Author(s)	Details	Projection period/Results
		computed from the age structure statistics, but enters as a single variable in model.	Ageing effects contribute to the increased pressure in health expenditure and peaks in 2012 to add about 1.3% per year to total expenditure. By year 2040 this increase is equivalent to about 3% of GDP.
Japan	Tokita *et al*. (1997)	Two econometric models used to forecast health expenditure. Historical data on expenditures and utilization used as inputs. Model I – Used estimated equation to model future medical expenses by age-group (elderly = 65+) and by type of service (inpatient/outpatient). Looked at 4 likely cases according to the assumptions about medical expenses and the utilization of services. Used past trends of medical expenditures per patient to estimate future time trends by regression analysis. Assumed expenditures to be subjected to technology change, institutional organizational changes, medical system delivery changes, etc. Utilization of medical resources (influenced by disease patterns, and policy /co-payment measures) was assumed to be relatively stable over time. Model II – Projected expenditures by medical institution (hospital vs. clinic) and by age group. Population divided into elderly (70+) and non-elderly. Assumed expenditures per patient and utilization of resources to remain at 1993 level. Other assumptions: Current health care system to continue in existence. # of projected population (medium estimation) taken from the National Institute of Population and Social Security Research at the MHW.	1993 – 2025 Model I case 4 considered to be more likely; per capita medical expenditure to grow over time due to technology and an increase in income Elderly expenditures to increase to ~49 trillion yen in 2025. Share of elderly expenditures between 1993 – 2025 ranges from 63.1-64.2% of total expenditures. By Model II the share of elderly expenditures is 58.8%of national medical expenditures in 2025 (45.2% Hosp., 13.6% for clinics). [elderly share in the population is 21.7% in 2025].

Country	Author(s)	Details	Projection period/Results
More Developed Countries (MDC) to include OECD countries, Eastern Europe, and newly independent countries in the European part of the former Soviet Union Less Developed Countries (LDC) include China India, the newly independent Central Asian countries of the former Soviet Union	Mayhew (2000)	International Institute for Applied Systems Analysis (IIASA) global economic-demographic model. Uses a "growth factor" model approach to analyze and estimate health care expenditure in time combining 2 growth rates: • Demographic change (a change in total population and in age structure). • A residual (reflecting technological change, changes in per capita utilization, care provided) normalized by an index of population size and structure. Data Sources: IIASA world population projections, OECD databases, Eurostat, UN and WB (major shortcomings noted in health and disability data for LDCs). Assumed a 3% pa rate of future growth in Health Care Expenditure (HCE) in the MDC region (about 1% below OECD rate prior to 1995), and although no reliable historical growth rates available to LDCs, they assumed the same 3% p.a. rate.	2000 – 2050 MDCs HCE will grow from 9.8% GDP in 1995 to 16% of GDP by 2050. Future pressures on health services will come form population ageing not due to volume (population increase). Coverage of key indicators is less due to gaps in data for LDCs. LDCs HCE (public and private) to increase to 13.8% of GDP more rapidly than MDCs (due to less effective technology and cost containment measures). In the period up to 2020, expenditures are more prominent due to population growth and the ageing component is only beginning to be felt, but after 2020 the ageing impact with substantially increase.
United States (Total National Health Expenditures)	Heffler *et al*. (2005)	Mixed projection model approach based on previous actuarial modeling approach. Current methods involve a mix of econometric analysis, actuarial projections and other techniques. Projection of total national health expenditures: • Medicare (Hospital Insurance and Supplementary Medical Insurance) and Medicaid projections: separate actuarial projections based on 2004 Medicare Trustees Report.	2004 – 2014 Gives the total average annual growth of national health expenditures (from prior year). Total health spending to increase from 15.3% in 2003 to 18.7% by 2014.

Country	Author(s)	Details	Projection period/Results
		• Private health spending projections: multi-equation econometric model incorporating historical National Health Expenditure (NHE) data (NHE projection model). • Prescription drugs: latest cost estimates and assumptions from the President's Fiscal Year 2006 Budget. For the first time projection include the impact of Medicare Part D (Medicare Prescription Drug, Improvement, and Modernization Act of 2003 (MMA). NHE Projection Model = Personal Health Care (PHC) + Non-PHC. Exogenous Inputs: • Macroeconomic (growth, inflation) and demographic variables are derived from the annual projections of the Board of Trustees for Federal Old Age and Survivors Insurance and Disability Insurance (OASDI). • Disposable personal income projection (influenced by fluctuation in taxes, government transfer payments, stock depreciation, earnings and transfer of private business). • Projections for wage and price growth based on an econometric model. The aggregate model for PHC is composed of prescription drugs, hospital, dental, durables, nursing home, home health, physician, professional, and non-durable services Non-PHC category is composed of administration and cost of private health insurance, research, construction, and government public health.	
China	Jamison *et al*. (1984)	Compared health expenditure (actual and predicted) of China to 19 other Less Developed Countries (LDC) (1975 per capita GDP lower than $2000).	1975 – 1981 Estimates of 1981 values converted to 1975 constant dollar prices.

Country	Author(s)	Details	Projection period/Results
		Expenditure inputs: • Salaried health personnel; barefoot doctors, health aids, midwives, salaried personnel. • Medicines; western, traditional (a high proportion of total costs were attributed to drug costs). • Medical equipment and beds. Prediction based on an OLS equation estimated for the LDC sample.	At constant 1975 prices, per capita health expenditure in china is estimated at $7.1 which is 25% greater than the $5.7 per cap expenditure level predicted from the LDC sample.
Jordan	Nandakumar *et al*. (2004)	Econometric approach based on modeling expenditures and utilization using cross-sectional household survey. Estimated expenditures on elderly stepwise: • Estimate total health expenditures (public, private, donor) for the base year using household survey data and costing studies • Used a model (Bloom et al. 2001) of macroeconomic growth to obtain attainable ceiling estimate on public expenditures in forecasting year • "age" survey data from the base year to obtain "survey data" for the forecast year • Apply econometric models to the aged data to obtain estimated expenditures for the projection year Strengths (+) and Limitations(-): + Considered expenditures on the elderly within the context of the entire health system (modeled all population sub-groups; not just elderly) + Took into consideration private expenditures as well + Methodology useful when longitudinal data sets are not available as the case is with many developing countries – Assumed 'ageing' the population Approach limits the modeling of sudden shocks to the system	2000 – 2015 Modeled Jordan's economic growth potential to grow at 5.6%, 2% and 3% per annum between 2000-2015. Elderly increases from 7% in 2000 to 9% in 2015. Elderly expenditures increase from 20.2% (of total health expenditure) in 2000 to increase to 23.2%, 32.7% or 37.9% under a 5.6%, 3%, or 2% per annum growth rate assumption.

A.2: Macroeconomic general equilibrium models

Country	Author(s)	Details of Methods	Projection period/Results
United States	Warshawsky, (1994)	Analysis to compare predictions and performance of macroeconomic general equilibrium model approach with traditional actuarial model approach for projecting health spending. Macroeconomic general equilibrium model: • Uses a two sector (health care and everything else,) and a two factor (labor and capital) general equilibrium model. Health care is produced in a Leontief fashion ((input of labor and capital in fixed proportions), but the rest of the economy assumes Cobb-Douglas production function (substitute labor and capital). • Assumed savings are a constant proportion of income and labor supply is a function of demographic and sociological factors. • The scope for 'capital deepening' (introduction of new, sophisticated technology and equipment) in the health care sector is also included in the model. Actuarial model • General methodology and assumptions used similar to Social Security Administration (SSA) and Health Care Financing Administration (HCFA) actuaries. Demographic projections (optimistic, intermediate, pessimistic) of SSA actuaries are applied to estimates of heath care expenditures by age group made by HCFA actuaries and others. The result is further expanded by utilization rates and the rate of inflation of health care prices. • Inflation rates are assessed using a regression forecast and a 'structural' forecast based on projections used by HCFA. The regression forecast uses rate of health care price inflation as a dependant variable and the general price inflation and	1990 – 2065 Under the 'intermediate' SSA actuarial projection the proportion of age 65 and over to increase from 12 to 22½ % over the period, and more concentrated in the years 2010 – 2030. Health care expenditures projected to double (1/3 due to the overall growth of the population and the rest accounting to the ageing of the population). Under the regression forecast of the actuarial model, the ratio of health spending to GDP is projected to increase from 13% to almost 50% in 2065. Under the structural forecast of the actuarial model, the ratio of expenditures to GDP is projected to increase to about 30% in 2065. Under the assumption of 1%, 2% and 2½ % capital deepening, using the macroeconomic simulation model, the ratio of health expenditures to GDP is projected to increase from 12% in 1990 to 25%, 35% and 53% respectively by 2065.

		‘household exposure to health care costs’ (measured as out-of-pocket health payments as a % of total health expenditures) as independent variables. Assumes that the general inflation flows to health care price inflation as well and household exposure to health costs to continue at its 1990 level of 20%. • Earnings of health care providers and non-labor inputs of hospitals were factored in. • In addition to the demographic forecast, numerous other components including labor force participation rate, the unemployment rate, the rate of productivity growth and the relationship between productivity growth and earnings growth were factored in.	
United States	Warshawsky (1999)	See entry above in Table A.2	2000 – 2040

A.3: Epidemiological models

Country	Author(s)	Details of Methods	Projection period/Results
Poland	Baran (1995)	A simulation model measuring the effects of demographic changes in the utilization of hospital care due to selected groups of diseases (to demonstrate that the poor health status of the future population rather than demographic factors will increase public expenditure). Assumed organizational and financial condition of the Polish health care system to be constant, health care expenditure is distributed by the government and the amount of taxes collected is set equal to the total costs of providing health care. Used Denton and Spencer (Canadian) model of public expenditure on health care modified by author due to lack data and to suit Polish conditions. Models the total cost of health care (hospital services) as a function of the per capita cost of health care by age, sex, place of residence (urban, rural) and population structure. Cost simulations are based on four epidemiological forecast scenarios for increased utilization due to circulatory system diseases, neoplasms, injuries, poisonings and tuberculosis. Data: • Base year 1989-1990. • Ministry of Health and Social Welfare National Hospital Discharge Survey (National Hygiene Institute).	1995 – 2000/2010 Hospital costs (if totally covered by the state budget) and public expenditure to increase yearly (according to 2 demographic variants) by approximately (0.87% to 0.94%) for the years 1995-2000 and by (0.62% to 0.68%) for the years 2000-2010. Hospitalization due to circulatory diseases will cause a yearly increase in the current costs by 3.4% for the years 1995-2000 (didn't predict any further) [by more than 4 times the amount allotted for the foreseen population demographic changes]. Considered direct costs only – Did not measure loss of production due to illness, disability, premature mortality, etc.).
Chile	World Bank (1995)	A forecast model to estimate future trends for non-communicable illnesses, using a Markov chain model whose cells represent risk factor states associated with illness morbidity and mortality to simulate the effects of changes from a healthy state to the	1990 – 2030 Hospital costs for individuals 15 and older (because of the increases in the

Country	Author(s)	Details of Methods	Projection period/Results
		presence of a risk factor to death. Projected the number of individuals dying of specific illnesses or risk factors and used this data to forecast hospitalization costs in public facilities (by multiplying projected numbers of bed days by the average cost per occupied bed day). Undertook study to project morbidity and mortality trends using available cause-specific mortality rates and distribution of risk factors. Features included: • Each individual placed into a risk factor state by the presence of certain risk factors; (hyperlipidemia, hypertension, former/current smoker, heavy drinker). • Probability of death is a function of age, gender, risk factors present. • An individual may change their risk factor profile or may die of a specific cause during the year simulated. Mechanism of the simulation: Beginning with 1990, mortality/risk factor for each year is simulated using the following steps: 1. Remove the number of individuals who die in each risk factor state from the live population. 2. Determine the number of the remaining individuals in each risk factor state who change the state by either increasing or reducing the risk factor state. 3. Age the individuals by moving all alive to one year older. 4. Determine the number of individuals who enter the adult population at age 15 (WB projections were used to determine the size of incoming cohort of 15 years). 5. Advance the calendar year by one and repeat. Projected hospital costs given were based on a WB projection	prevalence of health risk factors and major causes of disease and death) to increase 13% by 2000 and 38% by 2030.

Country	Author(s)	Details of Methods	Projection period/Results
		model using disease and injury cost data on patients receiving care from public sector hospitals and from above simulation. Assumptions: • the proportion of HC costs to total costs will remain the same. • hospital costs divided into 1) health maintenance (treatment costs for non-fatal illnesses and injuries) and 2) mortality (costs for fatal illnesses and injuries). • no economic inflation due to technology or services.	

A.4: Actuarial models

Country	Author(s)	Details of Methods	Projection period/Results
OECD	Martins *et al*. (2006)	See entry in Table A.1	2005 – 2050
OECD countries: Australia Belgium Canada Czech Rep. Denmark Finland Japan Korea Netherlands New Zealand Norway Sweden UK USA	Antolin, Dang and Oxley (2001)	Actual projections based on work from national experts reporting using their own data and models: • Gives richer institutional results. • Not controlled for the use of assumptions within models and no consistency across countries. Population projections based on Eurostat projections for EU and national projections for other countries. Health expenditure projections by weighting per capita care costs per age/sex groups: • Korea did not include medical care costs paid under the social insurance system - used a regression analysis that included only GDP, the # of elderly and a negative time trend. This approach appears to have contributed to a relatively small increase in spending. • Norway based on a model for the production of public services using Leontief-type fixed coefficients for labor. • Belgium, Canada and Netherlands included LTC with health care costs. UK omitted. • Japan broke down age groups by over and under 70; Belgium by 5-year age groups and by sex. Countries vary in accounting trends in income, relative prices or technology: • Canada, Denmark, Sweden assume that costs will rise in line with productivity or wages, UK in line with real GDP.	2000 – 2050 Table 4 Age-related spending change in % GDP significantly differ across countries due to individual country estimates of costs per capita for elderly relative to younger age groups, as well as assumptions re: how these costs rise over time. Average increase over the 50 year period for the 14 countries listed is 3.0% - 3.5% points of GDP. For Australia, Canada, Netherlands, New Zealand, and USA increases of 4% or more are predicted. [Austria, France, Germany, Hungary, Italy, Poland, Portugal, Spain did not provide all components of age-related spending]

Country	Author(s)	Details of Methods	Projection period/Results
		• Netherlands add a set annual increase to the growth rate and assumed 'costs of death' increases with age. • Belgium established the impact of demand and supply factors using regression analysis. • Australia allows for strong relative price/income/quality effect. • USA costs are aligned on GDP per capita but allowed to rise more rapidly than GDP. All or some components of age-related spending, i.e., LTC, education, pension and early retirement programs, were not provided by all countries.	
OECD Countries Australia Canada France Germany Japan Netherlands Sweden UK USA	Jacobzone et al. (1998)	Examined future age specific disability trends for long-term care needs. Disaggregation of population by: • Age • Sex • Disability • Institutionalized / LTC 1996 UN demographic projections with a focus on mortality (assumed migration to have a neutral impact). Population projections by gender and 5-year age intervals. Limited the study up to 2020 to avoid variations in increases in life-expectancy than those suggested by current UN projections. For most countries implicit longer life for males translating into a rebalancing of the F/M ratio was not factored in. Projected the share of LTC expenditure in GDP (LTC/GDP) by estimating first for the baseline year and then multiplying by trends in the number of disabled, and dividing by trends in the number of wage earners (15-64 year population). This was done separately	1995 – 2020 Results vary for long-term care spending share of GDP amongst the countries. US remains stable or declines slightly. Canada & Germany- a moderate reduction in spending compared with the static hypothesis. Sweden – spending increases to remain moderate due to falls in disability and deinstitutionalization (although spending remains highest in Sweden ~3% GDP). Australia – moderation in increase due to a shift towards less costly forms of institutionalization.

Country	Author(s)	Details of Methods	Projection period/Results
		for community care (non-institutionalized) and institutionalized care Assumptions: • # of carers per disabled person is constant in the long-run, no productivity gains in long-term care activities. • Wage of carers relative to average wages in the community to be constant. Two projections of disability: 1. Dynamic trend; project past trends into the future (institutionalization rates or disability rates). 2. Constant approach; presents the results of demographic change only (assuming no change in institutionalization or disability). Disability/Institutionalization Data: France – specific surveys for institutions. UK – cross-sectional data from 1991 census. Australia - ABS survey on disability, AIHW data on hostels and nursing homes. Japan - Fukawa (1996) data on all long term inpatient hospitals, institution and nursing homes. Canada – National Population Health Survey (NPHS) for base year and Health and Activity Limitation Survey (HALS) for self care trends. Germany – data for institutions from Rothgang(1996), Vogler(1997) and Wille(1998). Spain – a combination of Institutional data. Norway – Central Bureau vor de Statistik and Social and Cultural Planning Office. USA – National Long Term Care Survey (NLTCS), National Nursing Home Survey (NNHS), census data. Study focus on severe disability (those with at least 1 ADL	UK – due to a moderate demographic increase. France – experiences a strong increase due to institutionalization. Japan – highest increase in spending due to a stagnating active population and the absence of deinstitutionalization. The share of GDP would more than double (static projection) and increase by 88% under the dynamic projection. Under the dynamic trend France would experience the strongest increase in institutionalized population/ It would remain stable in the USA and almost stable until 2010 in Sweden. Under the static approach prevalence of institutionalization would be 3-8% by the year 2020.

Country	Author(s)	Details of Methods	Projection period/Results
		restriction). Assumed that the institutionalized persons are disabled (Sullivan hypothesis).	
Australia	Productivity Commission (2005)	Multi-component actuarial cost projection model incorporating elements to account for end-of-life costs. Government expenditures included: • Hospital (include all capital consumption on health but exclude capital expenditure). • Pharmaceutical benefits. • Medical services (Medicare). • Other (health professionals, aids, appliances, community/public health, dental, ambulance services, research, administration). Health expenditure projection ('traditional' model): Used a formula to project expenditure for each component of health expenditure above (excluding hospital) in any year using: • Age specific per capita health care expenditure. • The number of persons of a given age in a given year. • The annual growth rate in per capita health care expenditures. Hospital expenditure projected incorporating costs incurred at the end of life. To project proximity to death expenditures: • number of future deaths (by age) is multiplied by the cost of a death in each age group (costs per death is based on UK data) Total projected hospital expenditure is the sum of expenditure associated with death and recurrent expenditure. Recurrent expenditure is projected based on the 'traditional' model above which combine the existing age profile of expenditure with projected	2002/03 – 2050 Total government (Australian Government + State Governments) health expenditure (excluding aged care) to increase from 5.7% from 2002-03 to 10.3% of GDP in 2044-45 (projections use a non-demographic growth rate of 0.6 percentage points above the projected growth in GDP per capita). Non-demographic growth factors; new technology, increasing demand due to greater wealth, future prevalence and treatment of diseases, excess health inflation). Impact of ageing: By 2045 the proportion of expenditure on>65 to increase to 57% of total government expenditure (10.28% of GDP). Aged care (for >80) expenditure projected to increase from 0.86% GDP to around 2.24% in 2045 (assumed modest reductions in age-

Country	Author(s)	Details of Methods	Projection period/Results
		population changes and changes in per capita costs. Aged care services (nursing home, hostel care, veterans home care, community care services) cost projection: • Derive participation rates by age/sex for each aged care program. • In any future year the # of participants in a program is calculated by multiplying the participation rate by the projected population in that group for that year. • Expenditure for each group is given by multiplying the number of participants in each age group by the average cost per participant. • Total expenditure is the sum of expenditure on each age group. Carer payments projected (assuming eligibility conditions for carer payments to remain unchanged): • The current cost per recipient of each payment. • Age profile of the people being cared for. • Projected population of Australia by age/sex	specific disability rates). Carer (at home care) expenditure projected to increase from 0.19% GDP to 0.21% in 2045.
Canada + 14 other developed nations: Australia Denmark Finland France Germany Ireland Italy Japan	Denton *et al*., (2001)	Using an index-theoretic framework, uses the age/cost profiles of physician spending to analyze "pure" effects of population change on physician costs and to decompose the effects into growth vs. ageing effects. Data for physician billings for 1995-96 from Canadian Institute for Health Information – Ontario Health Insurance Plan. Data set was converted to age/cost profiles, and applied these profiles to a range of populations, including historical and projected populations, and population of other countries (not the true age/cost country specific profiles).	2000 – 2040 Table 4: Up to the end of the first 2 decades Canadian population growth was the largest source of projected increase in the aggregate costs of physician services. During the next 2 decades (2020-2040) aging will be a more dominant factor. Of the industrialized countries, Australia, Ireland, New Zealand,

Country	Author(s)	Details of Methods	Projection period/Results
New Zealand Norway Spain Sweden United Kingdom United States		Projection A : "standard" projection. Assume fertility rates to remain constant, life expectancy to increase, and migration to change in accordance with recent levels. Projection B: "best guess" younger population projection. Fertility rates will rise, life expectancy will rise more slowly, and immigration will be at a set level. Projection C: "older populations" projection. Assume fertility rates to fall to a set rate, life expectancy to rise than projection A, and immigration to Canada to fall. Assumptions: Age/cost profiles to remain constant and only age/sex group to change with time (focused on 'pure' demographic effects). Holding age/cost constant the assumption is that there is no change in physician utilization including changes brought about by technological advances, medical knowledge, practice, and insurance plans.	Norway and the US projected same results (growth) as in Canada for 2000-2020. Between 2020-2040 population growth is the dominant source in the US, growth and ageing being equally contributory in Australia, and ageing to dominate in all other countries.
Finland	Antolin *et al.* (2001)	Project population trends/change (based on Statistics Finland), Cost of the pension system, and cost of care for the frail elderly. The projections present a more pessimistic development than Eurostat (1999), which assumes a slightly higher fertility rate than Statistics Finland, leading to a higher working age population in 2050. Statistics Finland also assumes a slightly lower net immigration and higher longevity rates leading to a lower-working age population. Assumes employed remains constant at levels in 2000.	2000 – 2050 Results based on others projections. Elderly 15% in 2000 to 27% in 2050. Increase of ~2% points of GDP between 2000 and 2050 in health care spending + 1-1.5% points for non-health (LTC, social services). Pension expenditures to increase from ~12% to over 16% 2030-50.
Japan	Ogawa (2003)	Nihon University Population Research Institute (NUPRI) long-term simulation model	2000 – 2025

Country	Author(s)	Details of Methods	Projection period/Results
		Model consist of three interdependent sub-models: population sub-model, economic sub-model, social security sub-model Population sub-model is determined by a set of economic and social security variables with a one-year lag and the variables in the other sub-models are determined using the computed demographic variables. Both fertility and mortality are endogenously determined and incorporated into the models. Recent government policy changes to public pension schemes and medical care plans have also been incorporated into the model. To measure the costs of government medical schemes due to the changes of the future population, the age specific total medical care cost is computed as the product of 4 matrices: Population by age and sex (x) age-sex specific probability of being enrolled in the scheme (x) age-specific medical care cost per case (x) age-specific incidence of receiving medical treatment. The parameters for the first matrix are derived from the population sub-model, while those for the other three matrices have been calculated from sampled data. Due to data limitations some matrices are calculated on an age-specific basis rather than an age-sex specific basis. Advantages: • Since all matrices are age-specific, the population growth effect as well as the age structure effect on medical care expenditure is captured. • Enables to accurately identify some of the sources if a rise in medical expenditure occurs.	Total number of those aged 65 and over grows from 22 million in 2000 to 37.3 million in 2025. The proportion of those 75 and over is projected to rise from 40.9% in 2000 to 59.6% in 2025. Total medical expenditure measured in nominal terms is expected to rise almost 1.9 times over the 25-year period and the increase is characteristic of the population aging and the technological progress. The share of national income required for medical expenditure rises gradually from 7.4% in 2004 to 8.7% in 2025.
New Zealand	Ministry of Health	Actuarial projection model incorporating coverage, price, health	2002 – 2051

Country	Author(s)	Details of Methods	Projection period/Results
	(2004)	state and disability components. Population divided according to age groups, gender and health state (non-disabled survivor or decedent (= last year of life), disabled survivor or decedent). Population projection by year accounting for changes in fertility, migration, mortality and disability rates. Initial costs are estimated for 2002 and adjusted for each year accounting for change in growth rate for coverage and prices. Per capita expenditure by age/sex: Calculated for each year by multiplying the cost by the # of people in each health state. Then the sums of these totals are divided by the total population. Assumptions: • Projected future trends in mortality, disability and growth in coverage and prices by analyzing historical trends (1951-2001) and other studies. • Assumed that the disability prevalence was stable over the historical period.	Projected expenditures under several scenarios (different sets of assumptions). Central scenario: Health expenditure for elderly to increase from 40% to 63% (but the ratio of spending on the average older versus younger persons will decrease approximately by 25%. Growth in coverage and prices, not population ageing, will continue to be the key driver of health expenditure.
Spain	Monteverde, (2005)	Actuarial cost projection model for LTC incorporating disability component. Combined data on unit costs of services with (mortality and morbidity factored in) of the population 65 and over to estimate future individual costs for LTC. Data obtained from national disability surveys. Included nursing home residents if stay is a year or less (did not include permanently institutionalized) - author comments that the underestimation of the prevalence of disability may be of minor importance due to the rate	1999 – 2010 LTC costs for women to be about 70% higher than for men aged 65+ and costs for in-home care to be twice as high in comparison to the combination in-home care with care in daily centers and residential homes. Even with a uniform decline in disability rates of 1.2% annually the

Country	Author(s)	Details of Methods	Projection period/Results
		of institutionalization of elderly being low (~3%). Takes into account restrictions to ADLs, severe restrictions to Instrumental Activities of Daily Living (IADL)s, and sensorial and severe cognitive restrictions (only considered restrictions that lasted over a year (permanent disability). Long-term care costs were estimated assessing the distribution of years of life to be lived in disability, evaluating unit costs for long-term care services (in-home care, residential homes, daily centers etc) and by calculating the overall costs by combining unit costs and the number of years in disability. Empirical costs were calculated as weighted averages of unit costs of each region of Spain, where the weights are the proportion of disabled people in each region. Data: Disability prevalence projections were estimated using 2 cross-sectional health surveys. Projected trends in prevalence rates by linearly adjusting across cohorts rather than age groups (people aged x in 1994 and x+8 in 2002) and resulting trend up to 8 years. This analysis did not take into account the levels of seriousness and assumed the same distribution of severity observed in 1999. Assumed long-term care costs to increase (by looking at the population under study and their expectations of recovery) with respect to inflation.	forecast did not yield a reduction in individual expected costs. The author suggest this is due to a 'relative' compression of morbidity (a higher (expected) overall life expectancy) leading to a decrease in the number of years lived with a disability but contributing to an increase in the durations of disability.
United Kingdom	Wanless (2002)	Projection of national health costs undertaken as part of high-level review of health financing options for the UK. Combination of data sources: Department of Health (DoH), Office for National Statistics, National Health Service (NHS) Scotland,	2002 – 2023 UK health spending (public and private) is projected to rise from 7.7% GDP in 2002-03 to 12.5%, 10.6%,

Country	Author(s)	Details of Methods	Projection period/Results
		Personal Social Services Research Unit (PSSRU), other academic institutions. Demographic projections by Government Actuary's Department (GAD) with migration and fertility factored in. Baseline spending for year 2002-03 extrapolated from 1998-1999 data. Health and social care expenditures broken down by activity and unit cost; inpatient, outpatient, Emergency Room visits, General Practitioner visits, Community care (psychiatric, dental, optical care), LTC, social care and further by age and sex, and where possible by disease and proximity to death (decedent/survivor). Modeled the possible impacts (of heath seeking behavior, technological developments, workforce issues, and productivity) in the form of 3 scenarios based on solid progress, slow uptake, and fully engaged. Projection method: • Multiply baseline activity rate by projected population for new activity level. • Incorporate additional activity impacts. • Multiply new activity levels by an adjusted unit cost to give an initial total cost. • Multiply this by total cost adjustments to get the final cost for that area. Changes in health status and health seeking behavior (demand for care), productivity gains, non-clinical quality impacts were factored in.	11.1% under slow uptake, fully engaged, and solid progress scenarios respectively by 2000-23. Health care expenditure per head will be substantially higher in the slow uptake scenario than the others reflecting the costs of delivering a high quality service with relatively low productivity gains and the highest level of demand. Main cost drivers found to be changes in productivity, consumer demand for health, service quality changes and technology.
United States	Culter *et al*. (1998)	Actuarial approach using econometric modeling to predict levels of utilization of health care in relation to disability and health state.	2000 – 2070 Average age of elderly population is

Country	Author(s)	Details of Methods	Projection period/Results
		Forecast changes in acute medical spending and long-term care spending using a basic framework factoring in: • Number of people in a particular age group at any given year • Average heath status of people in the age group in that year • Average medical spending conditional on heath status Population distribution forecasts from the SSA. Forecast of Medicare acute care changes account for: • Changes in age at death. • Disability among survivors. (data from a 1992 Medicare beneficiary survey and forecast from a regression of expenditures on age and disability). • Increasing per capita medical costs. Forecast of nursing home care using regressions and accounting for variables: age, marital status (widowed, divorced, never married), having children or lack of, disability rates, proximity to death (within the next 2 years).	higher but fewer people in the last year of life are older and potential significant reductions in disability may reduce average medical spending. Medicare spending on the aged relative to GDP to increase from 1.7% in 1992 to 22.3% in 2070 (holding constant age-specific spending) and to 17.2% in 2070 (accounting for change in age of death and 1% reduction in disability). Medicare spending on nursing home care increased from 1% in 1990 for all simulations: – (Holding constant age/sex utilization) to 3.5% – (Holding constant age/sex/marital status) to 3.8% – (Holding constant age/sex/marital status and a 1% annual reduction in disability rate over time) to 1.7%. – (Holding constant age/sex/marital status, but allowing for changes in disability and time until death, and a growth of nursing home costs at 4% per year) to 10.9% in 2070.
United States	Goldman *et al*. (2005)	The Future Elderly Model (FEM): a micro-simulation of Medicare eligible elderly over time to project health conditions, functional status and Medicare and total health care spending.	2000 – 2030 Scenario A: Per capita spending will be $8,759 per beneficiary in 2030 (in

Country	Author(s)	Details of Methods	Projection period/Results
		• Data drawn from sample of ~100,000 Medicare beneficiaries from Medicare Current Beneficiary Survey (MCBS) 1992-1999 • Prediction base year 2000: predicted from pooled weighted least squares regressions of total health care spending on risk factors (assumed not to vary over time), conditions (self reported and assumed to be permanent), functional status, and interactions of conditions and functional status. • Aged the cohort by simulating health and functional outcomes in the subsequent year. • Used MCBS data to estimate one-year hazards of dying, developing a new health condition, or entering a new functional state (1/2/3 ADLs, nursing home, death). • Based on the hazard models, predicted each person's probability of dying, getting a new disease, entering a new functional state using Monte Carlo techniques. • As the initial sample aged, replenished annually through 2030 with a new cohort of sixty-five year olds using data on the health of younger cohorts form the 1982-1996 National Health Interview Survey (NHIS) [i.e.: the health of 65 year olds in 2026 will depend on the health of 35 year olds in 1996]. • Modeled under 3 scenarios; 1. Preferred one forecasts the constellation of disease taking into account all of the information and the health of the younger cohorts from NHIS. 2. Assumes new entrants will have a constellation of diseases and disabilities similar to healthy cohorts in 1990s (this scenario ignores what is known about the disease and disability in the younger populations). 3. Assumes continued improvement in preventing disability among the elderly and the new entrants. Also projected expenditures assuming the impact of medical innovations and technology (devises, vaccines, drugs, treatments,	1999 dollars) Scenario C (most favorable): Spending per Medicare beneficiary will be 8% lower by 2030 ($8,032 per beneficiary) but an improvement in disability will also lead to mortality improvements and hence a larger elderly population. Total spending by the elderly shows little difference between scenarios A and B. By 2030 spending under scenario B is only 2% ($11.5 billion) less per year. By 2030 total spending would be $583 billion for scenario C, compared with $621 billion for scenario A for a savings of 6%. Limitations: No adjustment of estimates to reflect historical trends (this is to avoid "double counting" of new innovations/technology). Concludes that future society has a greater risk of spending due to medical technology than due to demography and health trends.

Country	Author(s)	Details of Methods	Projection period/Results
		and mythical compounds). For detailed model information see technical document “A Micro-simulation Model to Forecast Disease, Disability and Expenditures by the Elderly” at http://content.healthaffairs.org/cgi/content/full/hlthaff.w5.r5/DC2	
United States	Warshawsky (1994)	See entry in Table A.2	1990 – 2065
Hong Kong	Department of Community Medicine and School of Public Health (2005)	Adapted Wanless method (which requires expenditures to be broken down by age, sex, unit cost and activity level (inpatient per capita bed day or outpatient per capita visit). Activity levels assume age-sex specific use of care and quality of care to remain constant but account for changes in age-sex specific use of different types of care resulting from changes in the health status in the future years. Incorporates public expectations, technological changes, potential productivity gains into total cost projections. Expenditures non-related to age-sex breakdown (public health program, pharmaceuticals) were incorporated as ‘other’ health expenditure). Data: • HK Annual Digest of Statistics and HK Population Projections 2004-33. • Base activity levels from Hospital Authority and DoH for public care and Thematic Household Survey for private care. • Baseline unit costs and other health expenditures derived from Hong Kong Domestic Health Accounts 2 (HK DHA2). Assumes no major structural changes (i.e., financing reforms or provider remuneration) in the health system.	2002 – 2033 Regardless of the growth of health expenditure pattern (high, moderate, low), about half of total expenditure on health will be consumed by the aged (>65) which would be about 20% of the population in 2033. Projected total expenditure, public expenditure and private expenditure on health as a % GDP using various possible scenarios (permutations). Although a significant number of scenarios lead to higher spending levels compared to present 5.7% of GDP, it is possible to limit that growth to below 12% by 2033 (other scenarios).
Israel	Chernichovsky *et al*. (2004)	Uses an actuarial type framework to suggest that ageing of the population may not necessarily increase costs over time or be	2000 – 2050

Country	Author(s)	Details of Methods	Projection period/Results
		observed across nations. Factors/variables that may affect age-specific and aggregate costs of care of ageing: • Epidemiology and behavior – Suggest possible savings due to the decline in morbidity and mortality, which in turn contribute to a fall in age-specific unit costs especially amongst the middle-aged. • Economic development – Hypothesizes that income growth in conjunction with ageing is likely to increase aggregate cost of care. • Rising levels of education reduce demand and cost of care. • Access to care due to private insurance and public entitlement. Suggest these may be the strongest correlates of the high usage and cost of care associated with aging especially where the population is relatively poor. • Technology contributing to rising costs of labor or capital may depend on age-specific treatments. Performed a regression analysis using Health Services Survey (1993) data and estimated the determinants of health utilization by Tobit methodology. Models include following variables; gender, religion, marital status, immigrant status, health status (chronic condition), education level, household income measured by a crowding factor (#people divided by #rooms), health insurance.	Projection data suggest that Israel would allocate 11.49% of its Gross National Product (GNP) to health (medium projection) compared to the actual share of 8.90% in 1996. Age: for those aged 75+ category, an increase in age will decrease the use of specialists, and for age group 45-64 a decrease in the use of doctors. Gender: females over 75 visit specialists less than their counterparts. Health status: younger age groups visited doctors, specialists and nurses more frequently than older age groups (higher demand for health and medical care by the young compared to the old). Religion, marital status and immigrant status: shows no consistent relationship to medical care utilization. Income/wealth: Higher levels of crowding > indicate lower levels of income/wealth. Resulted in fewer visits to specialists in the age group 65-74. Education: Higher levels of education (technological progress) lead to less

Country	Author(s)	Details of Methods	Projection period/Results
			use of services among those below 65. Health Insurance: Higher levels of an insured population increase use of services, more so among the old.
Malaysia	Ogawa (1985)	Projection of government hospital medical care services for inpatients and outpatients. 3 categories considered: 1. Medical care services 2. Public health services 3. Other (administration, dental, training, pharmacy, research, development) 1. Medical care services To compute the expenditure of hospital services for out/in patients, obtain age-sex matrices on the out/in patient attendance rate and the average cost per out/in patient case: Projected population by age-sex (x) age-sex specific outpatient attendance (x) age-sex specific average cost per outpatient case = expenditure on medical care services for outpatients. Same method for inpatient calculations (didn't use this model – see below) Due to unreliable and limited data availability of patient demographics at a national level, an estimation of 3 behavioral equations adopted (instead of an age-sex matrix as above) 1. Hospital outpatient rate equation 2. Hospital inpatient rate equation 3. Average cost per case equation	Authors recommend utilizing the age-sex profile of expenditure in the future when data becomes available. The key equations have been estimated on the basis of annual data on socio-economic and demographic variables observed over the period 1979-1983 in selected states of Malaysia. Age-sex demographic projections by the Department of Statistics.

Country	Author(s)	Details of Methods	Projection period/Results
		The number of hospital inpatients/outpatients for (non-maternal) medical care services = projected population x hospital inpatient/outpatient rate. Total # of patients treated = inpatients + outpatients (as above) + maternal patients (fixed %). Total cost associated with medical care services = Total # of patients treated x Average cost per case. 2. Public health services As for medical care services, estimated behavioral equations (instead of age-sex matrix approach) on patient rate and on the Average cost per case using annual data on demographic and socio-economic variables). Total # of patients treated at health centers and dispensaries = estimated patient rate x projected population. Total cost associated with public health services = total # of patients x Average cost per case. Also measured the manpower requirements (elasticity of demand for the total number of public center nurses).	
Sri Lanka	Rannan-Eliya (2005)	Actuarial cost projection model (age-sex specific demand for services). Baseline expenditures for 2001 from Sri Lanka NHA (SLNHA) estimates for (1990-1999) extrapolated forward. Taken into account changes in population size and structure,	2001 – 2051 Project personal medical expenditures as a ratio of GDP based on 3 different economic forecasts (low, middle and high) Middle projection considered most

Country	Author(s)	Details of Methods	Projection period/Results
		utilization of medical services, productivity changes, price inflation and change in the macro-economy (civil war/peace agreement). Does not focus on epidemiology, age-related disability, and end-of-life expenditures (no reliable data existed to analyze these). Public sector expenditures for administration, preventative services and capital formation are added separately as a fixed share of GDP (assumed that these expenditures would increase linearly with GDP). Projection approach: • Multiply baseline activity rate for personal medical services by projected population • Adjust for changes in activity rate or health seeking behavior • Multiply new activity rates by adjusted unit costs or prices (inpatient admission or outpatient visit) for medical services • Add in separately costs of preventative and administrative services • Divide by overall levels of economic output	likely (no war, no reforms, cost drivers follow historical trends and a shift to private financing). Age 60-74 years to increase from 8%-19% and 75+ age group to increase from 2%-10% by 2051. Expenditures for 60-74 year olds triples from 0.4% to 1.2% and 75+ age group to increase from 0.1%-0.7% of GDP.
Thailand	Ogawa *et al*. (1988)	Computed age-specific total health expenditure as a sum of age-specific total costs for outpatients and for inpatients. Outpatient Ministry of Public Health (MoPH) component = (population by age-sex) x (age-sex specific incidence of recourse to outpatient care provided by MoPH) x (age-specific total outpatient care cost covered by MoPH). Data for population projections (1985) from National Economic and Social Development Board and 1981 Health and Welfare Survey. Used inpatient admittance data (1981) in Bangkok hospitals to	1980 – 2015 The index of aging of outpatients (those aged 35 and over / those aged 0-14 x 100) increases from 39.6% in 1980 to 142.8% in 2015 The proportion (distribution) of outpatient expenditures allocated to older patients (>35) increases from 53.2% in 1980 to 194.9% in 2015. The % age structure of inpatients to

Country	Author(s)	Details of Methods	Projection period/Results
		estimate cause-specific (disease-specific) age distribution of outpatients treated by MoPH's health facilities. Due to limitation of data, used inpatient information by assuming that cause-specific age distribution is comparable between out and in-patients. Also assumed that there is no difference in disease-specific age distribution of outpatients in Bangkok and rest-of-country. Also used data from a published small sample survey to obtain cause-specific average outpatient cost and used this information to calculate age-specific Average cost paid by each outpatient. Then these calculated age-specific costs were adjusted on the basis of data (gathered from provincial and rural health facilities) on the average outpatient cost covered by MoPH. The total outpatient expenditures for the base year 1980 were computed by multiplying these age-specific costs by the number of outpatients per age group. Inpatient (MoPH) component – similar methodological approach as outpatient component. Also estimated MoPH's investment costs using time-series data. Also attempted to analyze the allocative pattern of MOPH's future financial resources for the recurrent component by household type incorporating both fertility and mortality changes using Household Model for Economic and Social Studies (HOMES) household projection package. Also looked at medical care services provided by private hospitals and clinics and by government health facilities (by applying HOMES model) • Assumed a 4% annual increase in both in/out patient costs (this capture the changing patterns of illness).	increase from 97.2% to 361.0% and the proportion of inpatient expenditures to increase from 105.5% to 391.1% in 2015.

Country	Author(s)	Details of Methods	Projection period/Results
		• Assumed age profiles of in/out patient rates to remain unchanged (to offset the shift in demand for medical services from public to private and urban to rural areas).	

A.5: Other studies of interest

Country	Author(s)	Details of Methods	Projection period/Results
Egypt	Fairbank *et al*. (2000)	Health Sector Finance Reform Model – computer cost simulation model for Egypt. Based on data from a detailed national health care use and utilization surveys: the 1994-95 Egyptian Household Health Care Use and Expenditure Survey (EHHUES). Other data used include NHA, MoH budgetary data, etc. Data organized by age-sex, region, income and insurance status. World Bank population projections used for years 2005, 2010, 2020. The model generates cost predictions assuming different settings of parameter values for service/insurance entitlements, level of co-payments, cost of services, etc. HSFRM composed of 2 modules: 'service use' module and 'finance' module and connected through the use of matrices quantifying population, service use, and resource availability and dimensioned by age, sex, region, income and insurance statue. Its structure allows user to model the number of services actually needed/desired by consumers and the number of resources made available by producers and to quantify any imbalance. The finance module is quantified in terms of services and resources used, and determines the degree to which spending on health meet financial obligations incurred for services rendered. Drawback: model does not explicitly reflect ageing over time (divided into 4 age groups including 50+). Is not designed specifically for making projections, but more for examining impact of a number of policy scenarios in health care financing.	Scenario horizon: 1991 – 2020 Overall spending is projected to increase by LE 5.8 billion (a 77% increase) by 2000 or ~12% per year. Largest increases in spending to occur in household out-of-pocket spending (89%).

Country	Author(s)	Details of Methods	Projection period/Results
Thailand	Knodel *et al.* (1992)	Study projecting demand for hospital inpatient services measured in terms of admission and bed-days. Financial costs not estimated. Used the hospitalization rates (number of inpatient days) from a 1986 Health and Welfare Survey for each age group to estimate the number of days hospitalized in the future years by multiplying these rates by the projected # of persons in each age group. Assumed age-specific hospitalization rates will remain constant. UN demographic (medium fertility variant) projections used.	1990 - 2020 Between 1980 and 2020 the 60+ age group will triple in number and their share will rise from 5% to 13%. Growth of the elderly population will account for 45% of the rise in in-patient days by the entire population (even though the elderly will account for only 30% of the total population growth over the projection period). Concluded that population aging will increase substantially the need for hospital services beyond the increase that can be expected simply from population growth.
Switzerland (Proximity to death and health care expenditures)	Zweifel *et al*. (1999)	Studies the relationship between health care expenditure and age by analyzing longitudinal data (private health insurance records) on the medical costs of patients in the last 2 years of life as a function of patient age. This is an econometric analysis of health care expenditure of deceased Swiss individuals 65+, and suggests that expenditures depend on remaining lifetime but not on calendar age. Data collected are only for the subset of patients who died (not survivors), and exclude most younger persons. The study suggests that per capita health care expenditure is independent of population ageing.	
United Kingdom (Proximity to death and health care	Seshamani *et al.* (2004)	Using longitudinal hospital data from England, the Zweifel *et al.*, (1999) model is replicated to find that neither age or the proximity to death have a significant effect on hospital costs. Instead a regular probit two-part econometric model was used to show both age and proximity to death to have significant effects on quarterly hospital	

Country	Author(s)	Details of Methods	Projection period/Results
expenditures)		costs. The first part of the model examined the likelihood of being in hospital in a given quarter on patient age, sex, time to death, cause of death and social class. The second part examined the cost level as well as diagnosis, source of admission, place of discharge and marital status from one hospital episode to another. The model estimated the probability of being in hospital and costs once in hospital for different quarters prior to death. The study is designed to demonstrate model selection and the incorporation of proximity to death to the accurate assessment of the determinants of health care expenditures.	

A.6: Other ongoing studies

Country	Author(s)	Details of Methods	Projection period/Results
European Union	(Centre for European Policy Studies)	Ageing, Health Status and Determinants of Health Expenditure (AHEAD) Study A 3-year research project (Feb 2004-Jan 2007) funded under the EU 6th Research Framework. Program examines the future evolution of health expenditure in the enlarged EU. The general goal of the study is to investigate different key factors driving health care spending in the EU and selected candidate countries, looking both at those arising directly form ageing and at those affected by changing incomes, social change and methods of expenditure control. The study will refine existing estimates of the links between reported states of health, use of medical services, fertility rates and the demands on health services made by non-native populations. Particular attention is also paid to costs of care near death. The study will also look at methods of financial control, which may influence health spending. In addition to researching projections and scenarios, standard deviations, confidence limits for predictions of key variables such as healthy life expectancy and demand-driven expenditure levels are also studied.	

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