

Chapter 2

What has driven life expectancy gains in recent decades? A cross-country analysis of OECD member states

Countries with higher national income and health spending tend to have longer life expectancies. But these factors can only account for a part of life expectancy differences across countries. This chapter analyses the factors contributing to health status, including a closer assessment of the determinants of health that go beyond the health system. It shows that on average, a 10% increase in health spending per capita is associated with a gain of 3.5 months of life expectancy. The same rate of improvement in healthier lifestyles (10%) is associated with a gain of 2.6 months of life expectancy. Wider social determinants are also important: a 10% increase in income per capita is associated with a gain of 2.2 months of life expectancy, and a 10% increase in primary education coverage with 3.2 months. For income, minimum absolute levels are particularly critical to protecting people's health.

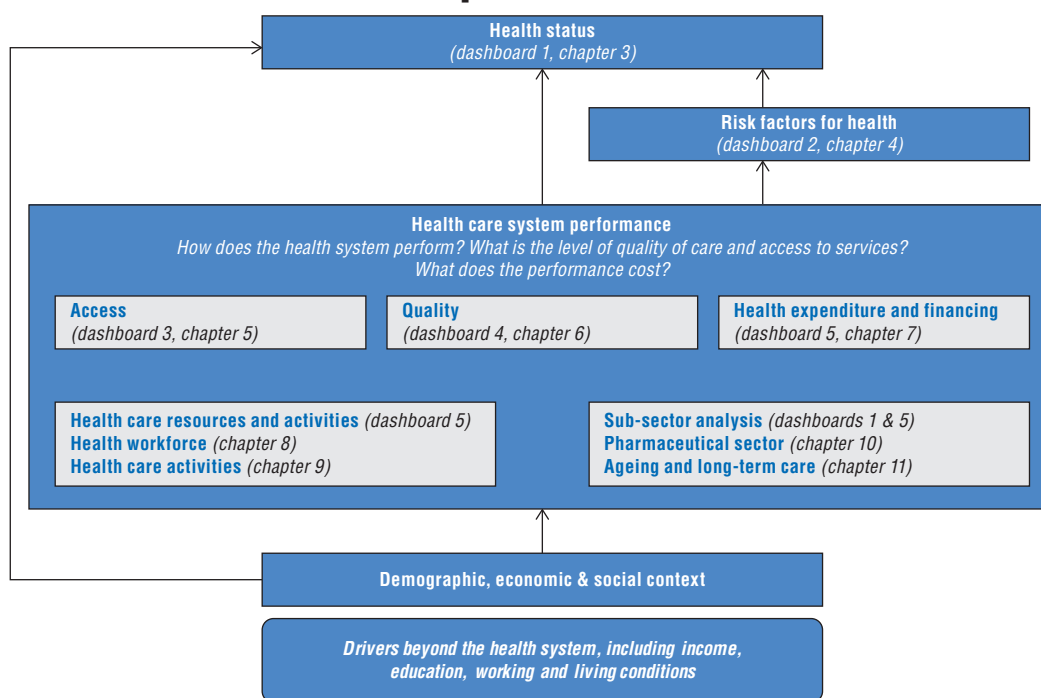
The main policy implication emerging from this analysis is the significant opportunities for health improvement from coordinated action across ministries responsible for education, the environment, income and social protection, alongside health ministries. This includes inter-sectoral action to address health-related behaviours. Collaboration with the private sector will also be important, especially with employers in relation to working conditions.

Introduction

Life expectancy has risen steadily in most OECD countries, increasing over ten years on average since 1970. Mortality rates from the main causes of death, cardiovascular diseases and cancer, have generally fallen. Today, countries with higher national income and health spending tend to have longer life expectancies. But these factors can only account for a part of life expectancy differences across countries. Furthermore, life expectancy varies across population groups. For example, life expectancy is lower amongst individuals with lower levels of education across all OECD countries (Murtin et al., 2017).

This chapter explores the determinants of life expectancy gains in OECD countries. These include drivers beyond the health system – the demographic, economic and social context – alongside health system factors. Such analysis complements subsequent chapters in this Health at a Glance edition, which focus predominantly on cross-country comparisons of health care system performance. Referring back to the conceptual framework underpinning Health at a Glance, this chapter analyses the factors contributing to health status, including a closer assessment of the determinants of health that go beyond the health system (Figure 2.1).

Figure 2.1. **Determinants of health and the Health at a Glance conceptual framework**



Analysis is based on country-level data for the time period 1995-2015, and covers all 35 OECD member states. Empirical findings are complemented by an assessment of the mechanisms by which drivers within and beyond the health system affect health.

Understanding the determinants of health

Health outcomes depend on investments both within and beyond the health system

Biological endowment and health service availability are not sufficient to explain differences in individuals' health. But a growing body of evidence has demonstrated that an individual's health also depends on factors that go beyond the medical care received (Marmot and Wilkinson, 2006; WHO, 2008). Some of these factors can still be influenced by health systems directly, through public health and prevention measures. In particular, non-medical determinants related to lifestyle choices are important. These include major risk factors such as smoking, alcohol and unhealthy diet, and conversely health-seeking activities such as physical activity.

But broader social determinants of health also matter. Income, education, working and living conditions are all also important factors. Having a sufficient income allows people to purchase essential goods and services that sustain or improve health, such as nutritious food and shelter; though higher income can also involve longer work hours and greater stress (Fuchs, 2004). The more educated, as well as often being richer, may be better informed about health-seeking activities (Mackenbach et al., 2008). Unemployment and poor working conditions adversely affect mental health, and certain occupations carry a greater risk of injury (Bassanini and Caroli, 2014). Living in an unsanitary, unsafe or polluted environment also increases the risk of illness or death (Gibson et al., 2011; Deguen and Zmirou-Navier, 2010).

The social determinants of health are closely inter-linked. Indeed, this makes it hard to empirically disentangle the individual effects of different factors on health (Fuchs, 2004). But what is evident is that these factors will, in general, reinforce each other. For example, the better educated are also likely to be richer, live in healthier environments, and be less likely to smoke. Further, some researchers argue that large income differences not only cause health inequalities, but may also be detrimental to population health (Pickett and Wilkinson, 2015). Finally, health inequalities are likely to persist over the life cycle and across generations, with early life circumstances influencing future health and economic prospects.

Further, despite the fact that most OECD countries have achieved universal health coverage, individuals from the most disadvantaged groups tend to have worse access to health services. For example, some individuals may be unaware or unwilling to use the full range of health services available to them. Quality of care may be worse in more socially deprived areas; co-payments and other direct payments by users without effective exemption mechanisms will disproportionately affect the poor (OECD, 2014, 2015a).

Studies using aggregated data highlight the contribution of socio-economic factors to health

A range of studies have estimated an empirical 'health production function' using aggregated data. Such analyses have been used to assess the contribution of health spending, socio-economic and other factors on population health.¹

In general, health spending, income and education have significant beneficial impacts on population health (Berger and Messer, 2002; OECD, 2010; Heijink et al., 2013; Moreno-Serra and Smith, 2015); with pollution and lifestyle factors (particularly smoking and alcohol consumption) typically having significant adverse effects (Shaw, 2005; Blázquez-Fernández et al., 2013). Far fewer studies have incorporated variables reflecting unemployment, occupational category or income inequality, and when included they have had more mixed results (Or, 2000; Lin, 2009).

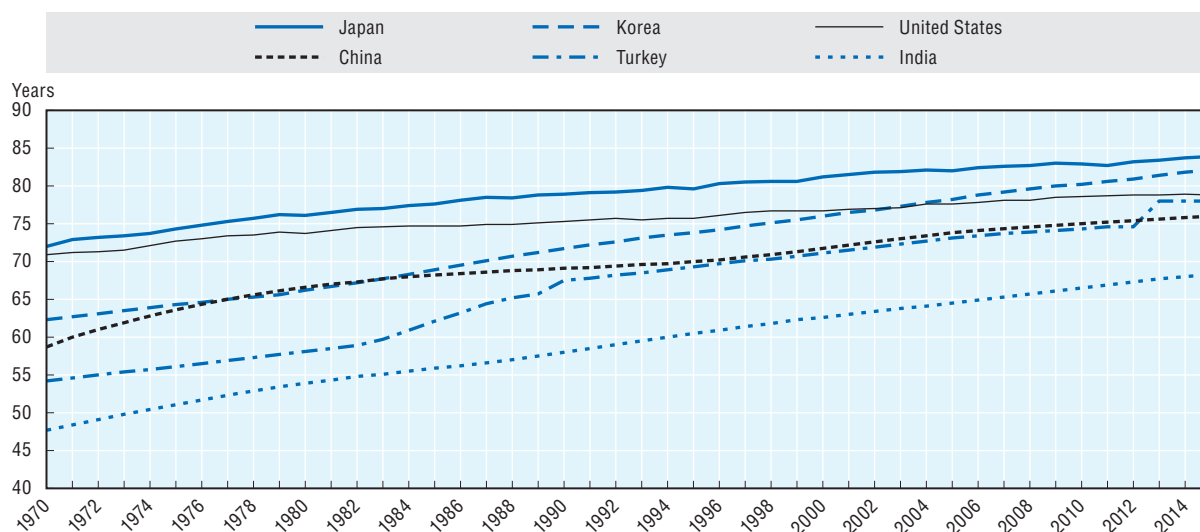
Note that health spending and income have typically had a stronger impact on reducing avoidable mortality or infant mortality than on increasing life expectancy (Heijink et al., 2013; Nixon and Ulmann, 2006). Dynamic factors may also be important. For example, temporary economic downturns have shown more mixed effects on health outcomes, worsening mental health but also potentially reducing mortality through reduced traffic fatalities and possibly lower pollution (Ruhm, 2012; van Gool and Pearson, 2014; Laliotis et al., 2016). More generally, differences in the countries analysed explains variability in the impact of different factors on health outcomes.

Gains in life expectancy over time reflect increased health spending, healthier lifestyles and improving socio-economic conditions

All OECD and partner countries have experienced gains in life expectancy over time, but the rate of increase varies markedly across countries

Life expectancy at birth increased in all the countries analysed. Gains have been particularly rapid in Turkey, India, Korea and China, countries which have had sustained periods of economic growth alongside improved health care coverage (Figure 2.2). In the United States and Mexico, gains have been more modest. There has also been slower progress in South Africa (due mainly to the epidemic of HIV/AIDS), Lithuania and the Russian Federation (due mainly to the impact of the economic transition in the 1990s and a rise in risk increasing behaviors among men). Life expectancy at birth is currently the highest in Japan, at 83.9 years.

Figure 2.2. Trends in life expectancy at birth, selected countries, 1970-2015



Source: OECD Health Statistics 2017.

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Increased health care spending had a strong positive impact on life expectancy, but wider social determinants are also important

New analysis provides estimates of the relative contribution of health systems and healthy lifestyles vis-à-vis socio-economic, and environmental factors across OECD countries. This analysis uses the latest cross-country data and follows best methodological practices (Box 2.1). Life expectancy gains from 1995 to 2015 are assessed. Data on explanatory factors were lagged by five years (i.e. using data from 1990 to 2010) to account for the delayed effects on health.

Box 2.1. Data and methods

The analysis assessed the relative contribution of factors within and beyond the health system to life expectancy gains between 1995 and 2015 in all 35 OECD countries. Macro-level panel data from OECD Health Statistics and the World Bank Databank was used.

An empirical health production function was developed, taking the following general form:

$$LE_{i,t} = \alpha_i + \beta_1 W_{i,t-5} + \beta_2 X_{i,t-5} + \beta_3 Y_{i,t-5} + \beta_4 Z_{i,t-5} + e_{i,t}$$

where $LE_{i,t}$ is the life expectancy at birth for country i in year t ; α the country effect; and e is the error term. Explanatory variables are 5-year lagged in order to capture the delayed effects of key determinants on life expectancy, with variable selection based on key determinants identified in the literature. Lags of 5 years were chosen to strike a balance between accounting for delayed effects on health and maintaining a sufficient number of observations for the time-series analysis.

W is a vector of health system variables in year $t-5$ (*health care spending*, including both curative and preventive care, measured by total health expenditure expressed in per capita constant USD PPP; *financial protection* using the share of out-of-pocket spending in total health expenditure as a proxy). X is a vector of lifestyle factors in year $t-5$ (*prevalence of daily smokers*; *alcohol* consumption in litres per capita; *healthy diet*, measured by the share of the population consuming vegetables daily). Y is a vector of income and other socio-economic variables in year $t-5$ (*income* measured by GDP per capita at constant USD PPP, net of total health expenditure; *education* measured as the share of the population attaining above primary school education; and the long-term *unemployment* rate). Z is an environmental variable in year $t-5$ (*air pollution* measured by the share of the population exposed to fine particulates PM2.5).

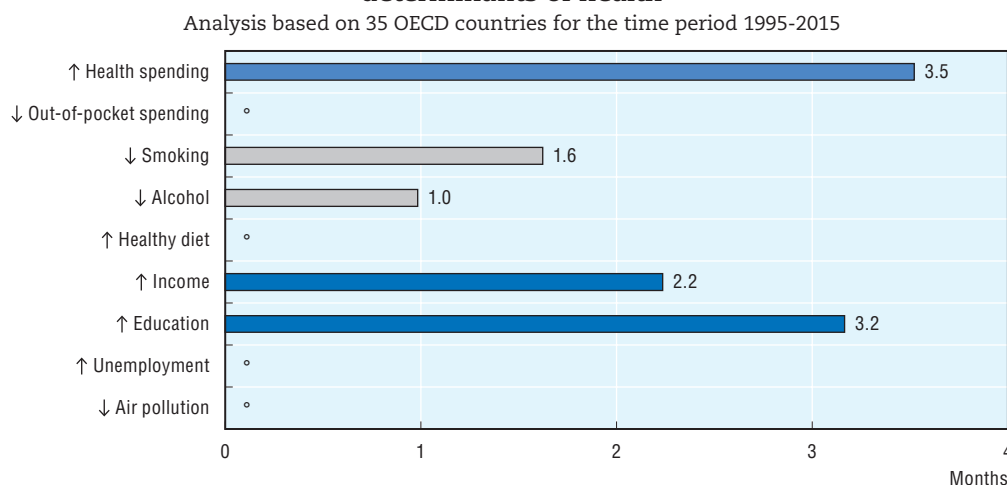
A Cobb-Douglas production function is used, where all variables are expressed in logarithmic form. The general econometric specification is a GLS model with country fixed effects, country-specific autocorrelation structures for errors, a correction for heteroscedasticity, and lagged explanatory variables. Data gaps in specific years were addressed using linear interpolation. Further empirical models are examined in a related working paper (James et al., forthcoming). Although the analysis follows best methodological practice, associations between life expectancy and explanatory variables do not guarantee causality.

Results from this analysis show that increased health spending, healthier lifestyles, higher incomes and better education coverage over time have positive and statistically significant associations with life expectancy gains (Figure 2.3). In particular, a 10% increase in health spending per capita (in real terms) is associated with a gain of 3.5 months of life expectancy. The same rate of improvement in healthier lifestyles (10%) is associated with

a gain of 2.6 months of life expectancy (fewer smokers with 1.6 months, decreased alcohol use with 1.0 month). Wider social determinants also matter. A 10% increase in income per capita (in real terms) is associated with a gain of 2.2 months of life expectancy, and a 10% increase in primary education coverage with 3.2 months.

The share of out-of-pocket spending in total health spending did not have a significant association with life expectancy gains, mainly because of its very small reduction over the time period studied. Healthy diet had a positive but not significant association with life expectancy. This may be explained by the very limited improvements to people's diet over time, and the difficulty to capture nutritional effects at the macro level. The association between long-term unemployment rates and life expectancy was also not significant.² More surprisingly, air pollution was also not significantly associated with life expectancy gains, despite there being clear evidence elsewhere of the adverse effects of air pollution on health (OECD 2016). This result reflects the long lag in time before air pollution affects a person's health, and also the relatively small decreases in air pollution over time in many OECD countries. These results are explored further in a related working paper (James et al., forthcoming).

Figure 2.3. **Life expectancy gains associated with a 10% change in the main determinants of health**



Note: ◦ stands for a contribution near zero.

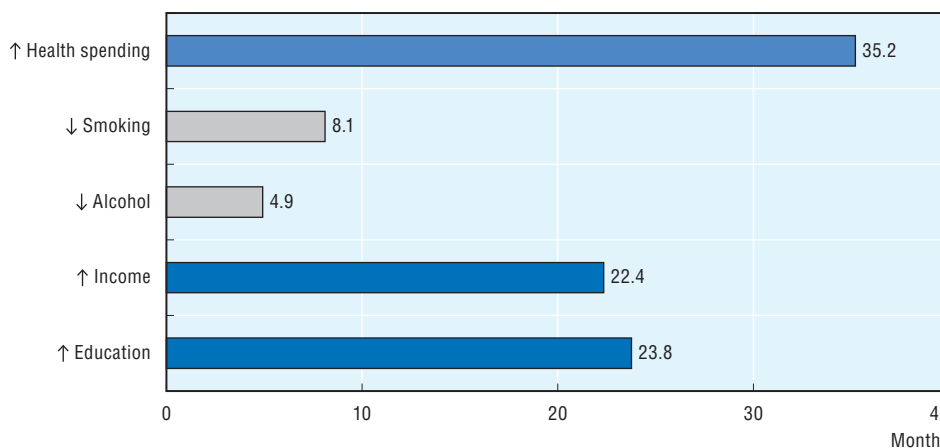
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While the effect on life expectancy of a 10% change in the main determinants of health is useful for comparative purposes, in practice larger changes may be feasible, leading to larger life expectancy gains. For example, if smoking rates and alcohol consumption could be halved, together these could lead to a gain of 13 months of life expectancy. Figure 2.4 illustrates the impact of more ambitious changes for selected factors, notably a doubling of health spending and income, primary education coverage reaching 100%, and more marked improvements in healthy lifestyles (a halving of smoking rates and alcohol consumption).

The actual evolution in the main determinants of health over the past 20 years has often been much more substantial than the 10% change used in Figure 2.3. From a policy perspective, this is relevant because it means the positive impacts on life expectancy can be substantial – given the right investments within and beyond the health system.

Figure 2.4. **Life expectancy gains from more substantial changes in the main determinants of health**

Analysis based on 35 OECD countries for the time period 1995-2015

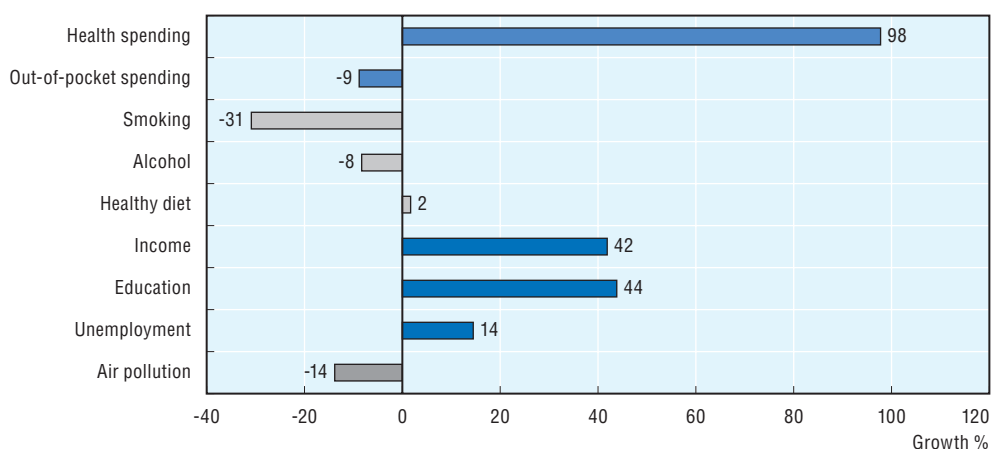


Note: Figures represent the gains in life expectancy that could be expected with doubling health spending, doubling income, reaching 100% of tertiary education, and halving smoking and alcohol use. Unemployment, healthy diet, out-of-pocket spending and air pollution are excluded because they were not statistically significant.

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Figure 2.5 shows the percentage change of these determinants of health between 1990 and 2010. For example, while a 10% increase health spending is associated with a gain of 3.5 months of life expectancy, health spending actually grew by 98% from 1990 to 2010 (from USD PPP 1 624 in 1990 to USD PPP 3 212 in 2010 in constant terms). Income increased by 42% over the same time period, and education coverage by 44%. Improvements in healthy lifestyles have been less marked: smoking rates were reduced by 31%, but alcohol use only fell by 8% and the rate of daily vegetable consumption only increased by 2% from 1990 to 2010.

Figure 2.5. **Evolution of the main determinants of life expectancy: OECD 1990 to 2010**



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As a result of the evolution of these determinants over time, health spending has been the major contributing factor to gains in life expectancy over the last two decades, followed by education then income (Table 2.1). The contributions of lifestyle factors (smoking, alcohol,

healthy diet) have been smaller, largely because there have been smaller improvements in these factors over the time period studied. Table 2.1 also shows regression coefficients and values for 1990 and 2010, alongside the relative contributions of each of these determinants of life expectancy.

Table 2.1. Determinants of life expectancy gains over time: regression coefficients, relative contributions, 1990 and 2010 values

Explanatory variables	Regression coefficient	Contribution to life expectancy (months)	1990 value	2010 value
Health system factors				
Health expenditure (per capita in constant USD PPP)	+ 0.039*	42.4	1 624	3 212
Out-of-pocket spending (as % of health expenditure)	ns	ns	22	20
Lifestyle factors				
Smoking (% daily smokers)	- 0.018*	5	30.3	21
Alcohol (litres of pure alcohol per capita)	- 0.011*	0.4	10.1	9.2
Healthy diet (% daily consumers of vegetables)	ns	ns	64.2	65.3
Income and other socio-economic factors				
Income (GDP per capita in constant USD PPP)	+ 0.025*	13.4	22 479	31 900
Education (% with above primary education)	+ 0.035*	15.1	57	82
Unemployment (% long-term unemployed)	ns	ns	3.2	3.6
Environmental factors				
Air pollution (% of population exposed to PM2.5)	ns	ns	75.7	65.2

Note: * statistically significant at the 5% level, 'ns' means not significant. Regression based on 718 observations across 35 countries. The sum of the contributions and the residual (not shown here) is equal to the total gain of life years over the studied period.

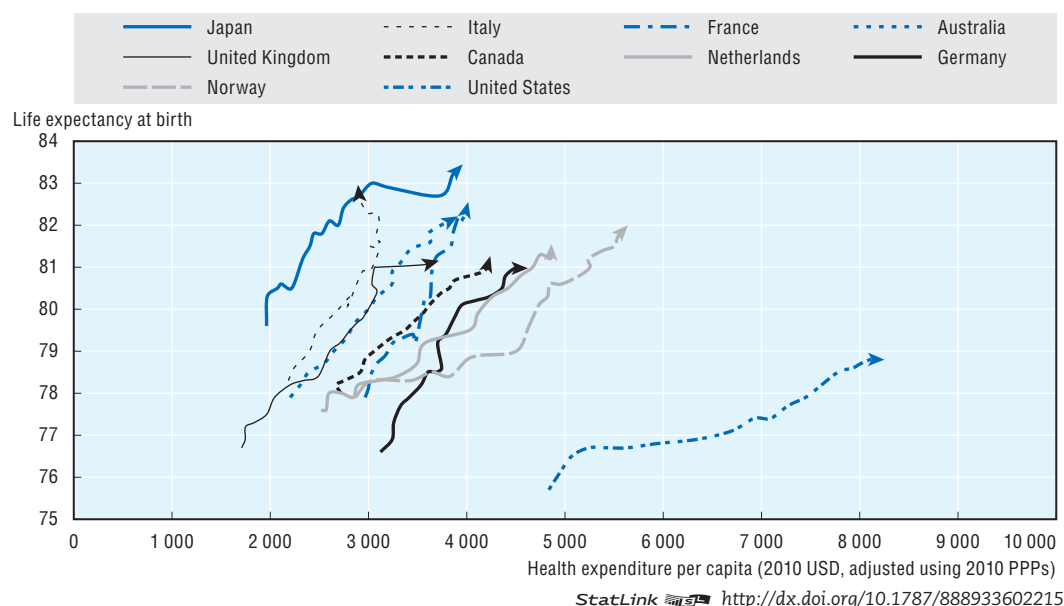
Supplementary analyses were carried out to test a range of common econometric specification issues, as well as alternative explanatory variables. These analyses showed consistent results (see James et al., forthcoming). Additional analysis adding OECD partner countries to the sample shows some differences in the determinants of health by a country's level of economic development. For high-income countries, health care spending has been the main driver of life expectancy gains, whereas income was the main driver in emerging economies. This analysis, though, was limited by data only being available for a shorter time period.

Most OECD countries have steadily increased health care spending in recent decades, but accompanying gains in life expectancy vary markedly across countries

While empirical analysis showed that health care spending has made a marked contribution to life expectancy gains across OECD countries as a whole, there are important cross-country differences. These are illustrated in Figure 2.6, which shows the trajectories of life expectancy gains alongside increase in health expenditure since 1995 for selected high-income countries.

In all OECD countries, both life expectancy and health spending have been increasing over time. But these rates of increase vary significantly across countries. The notable outlier is the United States, where health spending has increased far more rapidly over time than in other OECD countries, yet life expectancy gains have been smaller. On the other hand, life expectancy at birth in Japan has reached almost 84 years, but health expenditure per capita is less than half of the United States.

Figure 2.6. **Life expectancy gains and increased health spending, selected high-income countries, 1995-2015**



These varying trajectories for health expenditure and life expectancy across countries over time suggest the critical role healthy lifestyles and the wider social determinants of health have in increasing life expectancy. But these trajectories also point to the importance of improving value for money in health systems. This includes placing greater emphasis on health promotion and other highly cost-effective interventions, but also eliminating ineffective spending and waste (see OECD, 2017 for an in-depth discussion).

Unpacking the mechanisms by which socio-economic factors and a person's living environment affect health is essential for policy

The empirical results presented offer insights on the strength and relative contribution of different determinants of health. This section complements the macro-level analysis by assessing exactly how socio-economic factors and a person's living environment affect health and health-seeking behaviours, drawing on insights from more micro-level evidence.

The nature of income trajectories matter

The positive association between income and health is an important general finding. But examining how different income trajectories influence health status offers further guidance for policymakers. A first observation is the *importance of minimum absolute levels of income*. Whereas low income and poverty has a clear detrimental effect on health, health differences between individuals with average or high income are far less pronounced (Deaton, 2003). In other words, there is a non-linear relationship between income and health.

Second, *whilst current income matters, long-term income has a much greater impact on health*. That is, it takes time for higher (lower) incomes to have a beneficial (adverse) effect on health. For example, studies in the United Kingdom concluded that persistent poverty carries a much greater health risk than occasional episodes, and income level appears more important than income change (Benzeval and Judge, 2001; Contoyannis et al., 2004).

Third, *income reductions generally seem to have a larger impact on health than income gains*, irrespective of whether they are temporary or more permanent (O'Donnell et al., 2013).

For example, McInerney et al. (2013) found that wealth losses following the 2008 global financial crisis led to increased depression and use of antidepressants in the United States. In contrast, they observed no health improvements from wealth gains in the same study sample. In Sweden, self-assessed health responded to decreases in income to a greater extent than to income gains over time (Miething and Aberg-Yngwe, 2014). Similarly, most (but not all) studies of sudden wealth gains from inheritance, the stock market and lotteries find limited or no evidence of associated improvements in health status (O'Donnell et al., 2013).

Indeed, income payments can trigger adverse health events in some circumstances, probably reflecting an increase in more risky behaviours. For example, Dobkin and Puller (2007) found elevated drug-related admissions and within-hospital mortality in California for recipients of federal disability payments around the time of payment. Evans and Moore (2011) found increased risks of traffic accidents and heart attacks immediately after social security payments, wage payments for military personnel, tax rebates and dividend payments.

Unemployment worsens mental and physical health; employment conditions are also important

As discussed earlier, macro-level studies of unemployment on health find mixed effects. In contrast, micro-level studies more consistently find that *being unemployed adversely affects both mental and physical health*. For example, a meta-analysis of studies using individual data found that unemployment is associated with a 63% higher risk of mortality after controlling for age and other control factors (Roelfs et al., 2011), although this may partly reflect pre-existing health conditions. Unemployment also affects mental health. In Australia, Canada and the United Kingdom, evidence from panel data shows that changing from employment to unemployment significantly increased mental distress (Llena-Nozal, 2009).

Employment conditions also matter. Working longer hours are harmful to health, raising general stress levels but also increasing the risk of stroke and coronary heart disease (Kivimaki et al., 2015). In extreme cases, it may raise the risk of major accidents (Harrington, 2001). Choice over working hours has also been shown to be crucial, irrespective of the number of hours worked (Bassanini and Caroli, 2014). Other aspects of job quality are also important. Exposure to hazardous substances and risk of injury is typically concentrated amongst low-skilled menial labour (Clougherty et al., 2013). Job insecurity and job dissatisfaction has also been shown to adversely affect health (Caroli and Godard, 2014; Datta Gupta and Kristensen, 2008).

Education encourages healthier lifestyles

Better educated individuals and their offspring are healthier, independent of income and employment-related effects. A large part of this difference has been attributed to healthier lifestyles. In particular, *the more educated are typically better informed about the risks and benefits of different behaviours, but also more likely to process and act upon this information*. For example, people with lower education levels are more likely to smoke, be obese, have less well-balanced diets and be less physically active (Mackenbach et al., 2008; Cutler and Lleras-Muney, 2010). The evidence on alcohol, however, is more mixed. A recent OECD report found that in general better educated women were more likely to drink excessively, though the opposite held true for men (OECD, 2015b). At the same time, alcohol-related harm is more prevalent among less educated and low-income groups, partly because of multiple comorbidities (coexisting risk factors) and lower access to health care.

The better educated are also *more knowledgeable about exactly which health services are available* to them, with consequently greater use of certain services. This is particularly noticeable in terms of use of preventive health services and specialist consultations (OECD, 2006). Further, *education may improve self-management* (and therefore the efficacy) of medical treatment, particularly for chronic diseases (Goldman and Smith, 2002).

Disadvantaged population groups are more likely to experience inadequate living conditions, and adverse health effects from pollution

Air pollution was not significantly associated with life expectancy changes in the empirical analysis presented earlier, principally due to there being rather small decreases in air pollution over time in many OECD countries and because of the lagged effects of air pollution on health. Nevertheless, air pollution is a major health concern, linked to respiratory diseases, lung cancer and cardiovascular diseases.

The level of *pollution* varies greatly across different neighbourhoods, with consequent effects on health. A review found that poorer and less educated populations often (but not always) lived in areas with worse air pollution, but also were far more likely to experience negative health effects from air pollutants (Deguen and Zmirou-Navier, 2010). The authors posit this reflects a greater susceptibility because of factors such as higher prevalence of chronic conditions and greater long-term exposure to pollutants. More generally, children and the elderly are particularly vulnerable to air pollution.

Alongside pollution, other aspects of a person's living environment also impact upon their health. *Poor housing conditions* and certain *neighbourhood characteristics* such as the risk of crime have frequently been shown to adversely affect health (Gibson et al., 2011). Households with low-incomes and many ethnic minorities are more likely to experience these inadequate living conditions. Policies targeting better housing infrastructure (home visits, removal of hazards) and rental assistance policies, have had positive health effects (Bambra et al., 2010).

Conclusion

Empirical results demonstrate that while life expectancy depends on factors both within and beyond the health system, health spending has been a major driver of life expectancy gains in recent decades. In particular, a 10% increase in health spending per capita (in real terms) is associated with a gain of 3.5 months of life expectancy. Given the notable evolution in health spending in the last 20 years, higher health spending is associated with 42.4 months of life expectancy gains in this time period.

Education and income have also made significant contributions to life expectancy gains. A 10% increase in education coverage is associated with a gain of 3.2 months of life expectancy, and a 10% increase in income per capita with 2.2 months. The same rate of improvement in healthier lifestyles (10%) is associated with a gain of 2.6 months of life expectancy (fewer smokers with 1.6 months, decreased alcohol use with 1 month). Other factors – out-of-pocket spending, healthy diet, unemployment, air pollution – had smaller effects at the aggregate level. For some of these factors, notably air pollution and healthy diet, this may reflect long time lags before they affect an individual's health.

These empirical results provide a useful aggregate picture of the relative importance of investments within and beyond the health system. Looking forward, future analysis using such macro-level data could include variables that proxy health policies and institutional characteristics, and sub-national analysis.

It is important, though, to reiterate that observed associations between life expectancy and explanatory factors at this macro-level does not guarantee causality. Indeed, it is important to recognise two-way causality, as ill-health worsens productivity, hinders job prospects, and adversely affects human capital development. For this reason, a review of more micro-level evidence was also undertaken. Such evidence was generally consistent with the macro-level analysis, while also providing further precision on the mechanisms by which different socio-economic factors and a person's living environment affect health. For example, the empirical results showed that income has a strong positive association with life expectancy. Micro-level evidence adds to this by demonstrating that the nature of income trajectories matter: persistent poverty has particularly adverse health effects, and falls in income have a larger impact on health than income gains.

Taken together, the main policy implication emerging from this analysis is the significant opportunities for health improvement from coordinated action across ministries responsible for education, the environment, income and social protection, alongside health ministries. This includes inter-sectoral action to address health-related behaviours. In this regard, the WHO Health in All Policies (HiAP) framework provides countries with an approach that systematically accounts for the health implications of public policies across sectors (WHO, 2013). Collaboration with the private sector will also be important, especially with employers in relation to working conditions. Particular attention should be paid to early childhood, since early life circumstances are crucial to future health and economic prospects, as well as to shaping health-related behaviours later in life. Such policies can help reduce health inequalities and achieve better health outcomes for all.

Notes

1. The studies referenced in the text are based on a systematic review of the literature, based on studies from 1995 or later that included OECD and/or BRIICS countries. Note that such econometric analyses face some common methodological issues, including two-way causality and delayed effects of certain factors on health outcomes. James et al. (forthcoming) explores these methodological issues in more detail.
2. A positive association with life expectancy is consistent with other country-level studies that have typically shown decreases in mortality (as well as morbidity) during economic downturns, when unemployment levels are higher (Ruhm, 2012). However, much of the observed correlation between unemployment and life expectancy in these studies has been explained by fewer traffic accidents and lower pollution (particularly as decreases in deaths have been concentrated among the elderly), rather than unemployment per se (Miller et al., 2009; van Gool and Pearson, 2014). Moreover, auxiliary regressions with interaction terms between unemployment and country dummies showed large variability in the sign and strength of this coefficient across countries.

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