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INCLUSIVE GROWTH AND HEALTH

Chris James, Marion Devaux and Franco Sassi*

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ABSTRACT

In response to observed growing inequalities in income and other dimensions of well-being, including health, the OECD launched an initiative on Inclusive Growth in 2012. The objective was to help governments find ways to make economic growth more inclusive, so that it translates into meaningful gains in living standards across key dimensions of well-being and different socioeconomic groups. This paper links health to the overall inclusive growth agenda. It assesses the two-way relationship between health and socioeconomic factors. An empirical health production function is specified, using data from 35 OECD countries for the period 1990-2015. This is complemented by a review of the related empirical literature, as well as successful policies across OECD countries.

The paper concludes that, in most OECD countries, gains in life expectancy reflected factors both within and beyond the health care system. A 10% increase in health spending is associated with a gain of 3.5 months of life expectancy from 1995 to 2015, on average across 35 OECD countries. 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, and decreased alcohol use with 1.0 month). Wider social determinants also matter. A 10% increase in income is associated with a gain of 2.2 months of life expectancy, and a 10% increase in education with 3.2 months. In practice, larger changes in the main determinants of health may be reached, 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.

Despite overall gains in population health, large inequalities in health still persist in most OECD countries. These health inequalities seem to have been persistent over time, and are particularly large in Central and Eastern Europe. Income, occupational status, education and a person's living conditions have both independent and inter-dependent effects on health inequalities. Worse health outcomes for minority ethnic groups also warrant particular attention in some settings. Improving health outcomes and reducing health inequalities requires coordinated action by ministries responsible for housing, education, income and social protection, alongside health ministries. Collaboration with the private sector is also important, especially with employers in relation to working conditions.

At the same time, better health conditions are central to the effective functioning of a country's economy. Healthy children do better at school; healthy adults are more productive at work, spend fewer days on sick leave and are less likely to be unemployed, with benefits for society at large, and not just for the individuals concerned. Particular attention should be paid to early childhood, since early life circumstances are crucial to future health and economic prospects. Without policy interventions, health and other inequalities are likely to persist over generations.

RÉSUMÉ

En réponse aux inégalités croissantes des revenus et d'autres dimensions du bien-être, y compris la santé, l'OCDE lance une initiative sur la croissance inclusive en 2012. L'objectif est d'aider les gouvernements à trouver des moyens de rendre la croissance économique plus inclusive, de sorte que cela se traduit par des gains significatifs dans les normes de vie à travers les dimensions clés du bien-être et les différents groupes socio-économiques. Ce document lie la santé à l'ensemble du programme de croissance inclusive. Il évalue la relation à double sens entre la santé et les facteurs socio-économiques. Une analyse empirique a étudié une fonction de production de santé, utilisant les données de 35 pays de l'OCDE pour la période 1990-2015. Cette analyse est complétée par un examen de la littérature empirique et des politiques efficaces dans les pays de l'OCDE.

Les résultats montrent que dans la plupart des pays de l'OCDE les gains d'espérance de vie observés au cours du temps étaient attribuables à des facteurs internes ou externes aux systèmes de santé. Un augmentation de 10% des dépenses de santé était associée à un gain d'environ 3.5 mois d'espérance de vie entre 1995 et 2015, en moyenne dans 35 pays de l'OCDE. Un même taux d'amélioration des modes de vie (10%) était associée à un gain de 2.6 mois (baisse du tabagisme associée à 1.6 mois et baisse de l'alcool à 1.0 mois). Les déterminants plus larges jouent aussi un rôle important. Une augmentation de 10% des revenus était associée à un gain d'espérance de vie de 2.2 mois, et une augmentation de 10% de l'éducation à 3.2 mois. En pratique, de plus grands changements dans les déterminants de la santé peuvent être atteints, conduisant à des gains d'espérance de vie supérieurs. Par exemple, si les taux de tabagisme et la consommation d'alcool diminuaient de moitié, ensemble ces facteurs conduiraient à un gain d'espérance de vie de 13 mois.

Mais, en dépit d'une amélioration moyenne de la santé de la population, il existe de grandes inégalités en matière de santé dans la plupart des pays de l'OCDE. Ces inégalités de santé sont restées persistantes au fil du temps, et sont particulièrement élevées dans le centre et l'est de l'Europe. Le revenu, le statut professionnel, l'éducation et les conditions de vie d'une personne ont des effets indépendants et interdépendants sur les inégalités en matière de santé. Un moins bon état de santé observé chez les groupes ethniques minoritaires mérite également une attention particulière dans certains contextes. L'amélioration des résultats de santé et la réduction des inégalités de santé exigent une action coordonnée par les ministères en charge du logement, de l'éducation, des revenus et de la protection sociale, aux côtés du ministère de la santé. Les collaborations avec le secteur privé seront également importantes, en particulier avec les employeurs en ce qui concerne les conditions de travail.

En même temps, un meilleur état de santé est essentiel au bon fonctionnement de l'économie d'un pays. Les enfants en bonne santé réussissent mieux à l'école; les adultes en bonne santé sont plus productifs au travail et moins susceptibles d'être au chômage, avec des bénéfices pour la société en général, et pas seulement pour les individus concernés. Enfin, une attention particulière devrait être accordée à la petite enfance, puisque les conditions de vie durant l'enfance sont essentielles pour la santé future et les perspectives économiques. Sans interventions politiques, les inégalités de santé et toutes autres inégalités sont susceptibles de persister au fil des générations.

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INCLUSIVE GROWTH AND HEALTH

1. Introduction

1. In response to observed growing inequalities in income and other dimensions of well-being, including health, the OECD launched an initiative on Inclusive Growth in 2012. The objective was to help governments to find ways to make economic growth more inclusive, so that it translates into meaningful gains in living standards across key dimensions of well-being and different socioeconomic groups. An individual's well-being depends on multiple aspects, and how these are distributed across individuals matters if economic growth is also to deliver social and economic sustainability. This paper links health to the overall inclusive growth agenda.

2. Health is a major dimension of well-being, offering individuals the capability to pursue activities which they find meaningful, as well as having intrinsic value (Sen 1985, Ruger 2010). Further, health outcomes are closely linked with income and other dimensions of well-being. The poor, less educated and unemployed are more likely to be in worse health or die prematurely than those in more favourable socioeconomic circumstances. Differences in health outcomes vary considerably across countries and the reasons for this are not always well understood. Causality also runs in the other direction: ill-health worsens productivity, hinders job prospects, and adversely affects human capital development. In other words, inequalities across dimensions tend to compound themselves. Finally, health inequalities can persist over the life-cycle, with early life circumstances influencing future health and economic prospects (Almond and Currie 2011; Case et al 2002).

3. Health is therefore a critical component of inclusive growth, both as a major dimension of well-being in itself and because of its relationship with income, employment and other dimensions of well-being. This paper analyses the two-way relationship income and other socioeconomic factors have with health outcomes. The focus of the paper is predominantly on health outcomes, rather than on access or fair financing of health services (for an analysis of inequalities in access, see Devaux and de Looper 2012).

4. The paper is structured as follows. The next section outlines how socioeconomic characteristics are related to health and health inequalities. Section 3 then provides a detailed analysis of the macro-level impact that income and other socioeconomic characteristics have on population health, alongside health spending and other factors. This includes a systematic review of existing evidence and results from new econometric analyses. Section 4 adds a health inequality dimension to the analysis. Section 5 considers a range of policies that can improve health and health inequalities. In particular, it provides an assessment of how policies affecting income, employment, education and living conditions can successfully complement health care policies. Causality in the opposite direction is explored in Section 6, by analysing how health status impacts on income, employment and education. Concluding comments are provided in the final section.

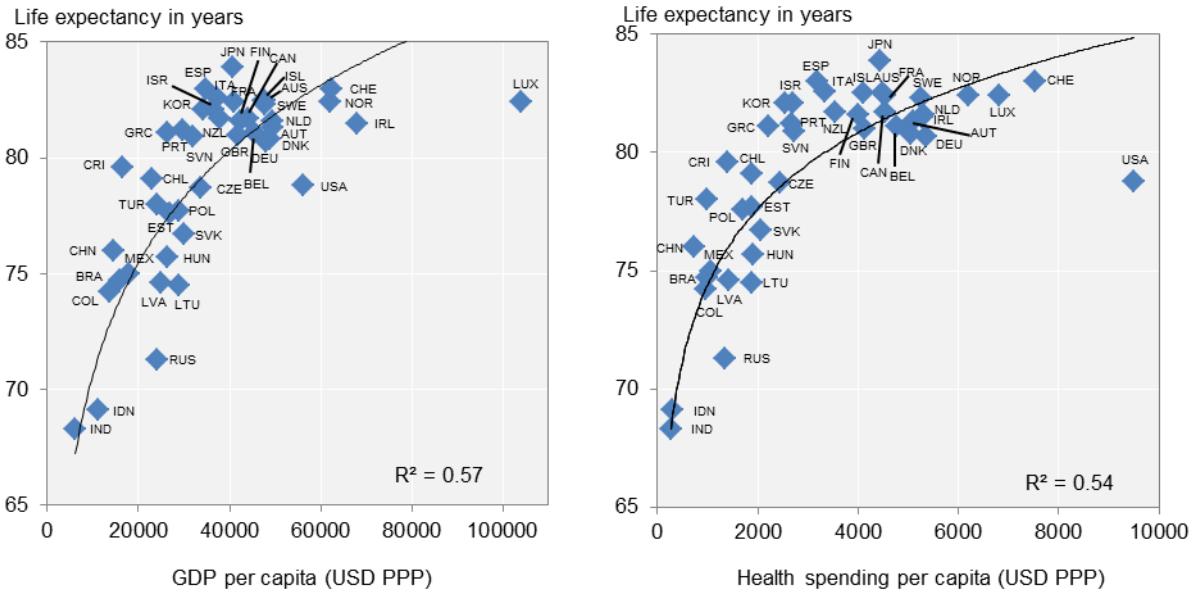
2. Health, health inequalities and socioeconomic characteristics: general insights

2.1 Despite overall gains in population health, health inequalities remain significant today

5. Life expectancy at birth has risen steadily in most OECD countries, increasing by over ten years, on average, since 1970. Mortality rates from the main causes of death in developed countries, cardiovascular diseases and cancer, have generally fallen. Such improvements have taken place in the context of virtually universal health care systems where the quality of care has steadily advanced over time (OECD 2015b). Today, countries with higher national income and higher health care spending tend to have longer life expectancies (Figure 1). However, national income and health spending can only account for a part of life expectancy differences across countries. Importantly, this relationship appears much weaker at higher levels of income and health spending (OECD 2017).

6. Furthermore, gains in life expectancy have not been equally shared. For example, life expectancy is lower amongst individuals with lower levels of education across all OECD countries. In Czech Republic, Estonia, Hungary, Latvia, Poland and the Slovak Republic, such differences are particularly large, with a gap in life expectancy between men having completed tertiary education and those with less than upper secondary education exceeding 10 years.

Figure 1. Life expectancy, health-care spending and national income (2013 or nearest year)



Source: OECD Health Statistics, http://www.oecd.org/els/health-systems/health-data.htm (reproduced from OECD Health at a Glance 2017)

2.2 The social determinants of health status are closely inter-linked, and there is a two-way relationship between health status and socioeconomic factors

7. Socio-economic differences in health outcomes suggest that biological endowment and health service availability are not sufficient to explain differences in individuals' health. A growing body of evidence has demonstrated that an individual's health also depends on broader social determinants (Marmot and Wilkinson 2006, WHO 2008), including income, education and other socioeconomic factors, as well as lifestyle choices and a person's living environment. From an Inclusive Growth perspective, a thorough understanding of these social determinants of health is a crucial step in developing suitable policies to reduce health inequalities.

8. Having a sufficient *income* allows people to purchase essential goods and services that sustain or improve health, such as nutritious food and shelter; but 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 the health-impacts of their personal activities and lifestyles (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).

9. *Lifestyle choices, personal* activities and risky behaviours such as smoking, alcohol, bad diet and lack of exercise affect health outcomes. Living in poor housing, as well as in unsafe or polluted *environments* also increases the risk of illness or death (Gibson et al 2011, Dequen and Zmirou-Navier 2010).

10. 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 status (Fuchs 2004). Importantly, the causes and equity implications of different individual characteristics on health can differ markedly (Deaton 2011). But what is evident is that these factors will, in general, reinforce each other. For example, better educated people are also likely to be richer, to live in healthier environments, and to be less likely to smoke. It is also possible that large income differences may not only cause health inequalities, but may also be detrimental to average population health (Pickett and Wilkinson 2015).

11. Further, despite the fact that most OECD countries have achieved universal health-care 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, such as immigrants with concerns over their immigration status. Quality of care may also be worse in more socially deprived areas; and co-payments without effective exemption mechanisms will disproportionately affect the poor (OECD 2014, 2015c).

12. The determinants of health status therefore extend beyond the health care sector. Concurrently, the determinants of a country's economic performance include the health status of its population. That is, there is a *two-way relationship between health status and socioeconomic factors*. People in good health are more productive; children in good health do better at school. The benefits of good health extend beyond the individual, with payoffs in terms of greater domestic savings and improved social stability (James 2016).

2.3 Behavioural choices are important to health status, but may be constrained by social circumstances

13. Economic theories seek to explain the social determinants of health on the basis of the behavioural choices made by individuals. Grossman's seminal health capital model and subsequent extensions show that, everything else being equal, greater levels of income, wealth and education will increase an individual's demand for health, and enable them to afford healthier working and living environments (Grossman 1972 and 2000; Galama and van Kippersluis 2013). A general policy implication of these theories is the emphasis placed on addressing income inequality and educational opportunity for improving health outcomes.

14. Insights from the sociology and psychology disciplines focus more on the health consequences of social disadvantage, rather than on differences in the demand for health care across individuals. Accordingly, policy recommendations are not limited to addressing income and educational inequalities, but also stress improving the wider set of conditions of daily life that affect health, alongside supply-side reforms in the health care system.

15. Some of the main findings of this literature have been synthesised by Marmot and Wilkinson (2006), Deaton (2003) and in WHO reviews (2003, 2008). Difficult social conditions limit the ability to pay for nutritious food, physical activity and other health-enhancing goods and services. In addition, they increase psychosocial problems such as stress, harmful coping mechanisms and exposure to violence. Social disadvantage can also perpetuate health inequalities over generations, since adult health is highly dependent on early childhood health and foetal development (Almond and Currie 2011; Barker 1995; Currie 2009). The persistence of health and other inequalities over a person's lifetime is explored in the OECD Ageing Unequally project.

3. The impact of income and other socioeconomic factors on life expectancy and mortality rates

16. This section presents empirical evidence on the macro-level impact a range of factors have on population health, focusing on life expectancy and mortality rates rather than morbidity. It first reviews existing evidence, then presents preliminary results of a new cross-country panel analysis of OECD Member States and key partners, including some of the major emerging economies.

3.1 Previous analyses highlight the contribution of socioeconomic factors

17. A number of econometric studies have adopted a 'health production function' approach. Such research provide a useful tool to assess whether socioeconomic characteristics have a significant impact on population health, and also their relative contribution to improving health vis-à-vis health spending and other factors. These studies include health spending and various other factors as the inputs used to produce the output of health. Most of these studies use aggregated, macro-level data and specify the health production function in the following general form:

$$H = f(HC, X)$$

where H is an aggregate measure of population health, HC is a vector of health care resources and other health system variables, and X is a vector of non-medical inputs. The vector X has typically included indicators for income, education and other socioeconomic and lifestyle-related factors.

18. One of the pioneering studies that adopted this general approach was that of Auster and colleagues study of population mortality rates across different US States (Auster et al 1969). They found that education had a greater impact on reducing population mortality than medical resources. Moreover, income had – after controlling for other factors – a positive association with higher mortality rates. They surmised this association could reflect more stressful, less healthy lifestyles of richer individuals. Tobacco use was also associated with higher mortality.

19. Subsequent empirical studies adopting the same health production function approach in different settings generally found income to have a beneficial aggregate impact on health outcomes. The relative importance of medical resources vis-à-vis education and other socioeconomic factors on improving health outcomes has also been much debated. For example, in contrast to Auster and colleagues early study, a 2010 OECD report, using pooled cross-country time series data covering 23 countries from 1981-2003, found differences in health spending to be the most important factor explaining differences in health status across countries and over time (OECD 2010a).

20. More generally, health spending, income and education have all been found to have significant beneficial impacts on population health; with pollution and lifestyle factors (particularly smoking and alcohol consumption) typically having significant adverse effects (Table 1). Far fewer studies have incorporated variables reflecting the possible impact of unemployment, occupational category or income inequality and, when these variables were included, empirical analysis have reported more mixed results.

Table 1 summarises the results of these econometric studies, based on a systematic review of the relevant literature. It shows which factors have most commonly been found to have statistically significant beneficial or adverse effects on population health, as measured by life expectancy or mortality rates, based on polled cross-country data. Further details of the findings from this systematic review are provided in Annex 1, including the approach adopted in the review, the criteria used for including studies in this review, and summaries of each study's main findings.

Table 1: The main determinants of life expectancy and mortality rates: collation of findings from health production function studies using cross-country panel data

Variable	Studies finding significant effect on health [i]			*(studies finding no statistical significance)*
	Beneficial	*Mixed*	*Adverse*	
Health spending per capita (total or government)				
- impact on life expectancy	4	1	0	(2)
- impact on mortality rates	9	1	0	(1)
Income per capita (GDP or related)				
- impact on life expectancy	8	1	0	(0)
- impact on mortality rates	9	0	0	(2)
Education level or literacy rate				
- impact on life expectancy	4	0	0	(1)
- impact on mortality rates	5	0	0	(1)
Pollution (nitrogen, sulphur or carbon dioxide, particulates)				
- impact on life expectancy	0	0	3	(1)
- impact on mortality rates	0	0	3	(1)
Tobacco use (prevalence or average consumption)				
- impact on life expectancy	0	0	6	(0)
- impact on mortality rates	0	0	5	(1)
Alcohol use (prevalence or average consumption)				
- impact on life expectancy	0	1	5	(1)
- impact on mortality rates	1	0	6	(0)

i) At 95% statistical significance level or higher

ii) Measures of life expectancy and mortality rates varied in terms of the population group/s studied (e.g. life expectancy at birth or later ages, by gender; overall, age-specific or premature mortality rates).

iii) Studies classified as finding *mixed* results are those where both beneficial and adverse health effects of the relevant variable were noted across different model specifications. Studies classified as *beneficial* include studies where a minority (less than 25%) of model specifications found insignificant results, alongside beneficial effects. The same rule was used for studies classified as finding *adverse* results. Studies classified as *insignificant* found statistically insignificant results across all or the majority (75% or more, and typically all) model specifications.

iv) Some studies used disaggregated health spending variables (e.g. pharmaceutical spending) or measures of physical resources (e.g. number of beds, physicians), with broadly consistent results to more aggregated measures of health spending. Some studies also included institutional characteristics of health systems. A small number of studies included measures of income inequality, unemployment, occupational categories, proxies for the living environment (e.g. degree of urbanisation, access to clean water and sanitation facilities), overweight or obesity prevalence, and consumption of healthy or unhealthy foodstuffs.

21. It should be noted that these econometric analyses face some common methodological issues, principally because they are based on macro-level aggregated data. Particularly important methodological challenges are how to address two-way causality between health outcomes and certain explanatory variables (i.e. whether to use instrumental variables approaches to limit endogeneity, and if so how); the high correlations between some explanatory variables; and how to account for the delayed effects (time lags) of certain variables on health outcomes.

22. The variability behind the general findings summarised in Table 1 are also important. Differences in the countries studied and in methodological approaches, affect both the strength and the significance of the impact of different factors on health outcomes. For example, the impact of income, health spending and

other variables have generally been found to be stronger in low and middle income countries as compared with high-income countries. Health care spending and income levels have also been found to typically have a stronger impact on reducing avoidable mortality or infant mortality than on increasing life expectancy (see, for instance, Heijink et al 2013 and Nixon et al 2006). Finally, 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).

3.2 New econometric analysis confirm these findings, whilst also showing the relative contribution of different factors to life expectancy gains

23. A health production analysis based on the latest cross-country data provides further insights on the relative importance of socioeconomic factors to life expectancy. This analysis extends previous OECD work (OECD 2010a) by expanding the time period and countries covered, considering a broader range of explanatory variables, and refining the econometric methodology. Life expectancy at birth for the total population is used as the health outcome measure. Explanatory variables reflect health care spending and access to care; income and other socioeconomic factors; lifestyle; and environmental conditions (Box 1). Data are drawn from the OECD Statistics database, complemented with indicators from the World Bank. This section presents the main results, with a full set of results and further methodological details available in Annex 2.

24. The main analysis covers 35 OECD countries for the period 1990-2015. The econometric specification used addresses to the extent possible key statistical issues. Key results from this empirical analysis are described below. Nevertheless, it is important to reiterate that observed associations between socioeconomic factors and health do not imply causality.

Box 1. Health production function analysis: variables used and econometric specification

The health production function used in this paper takes the following general form:

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

where $LE_{,t}$ is the life expectancy at birth for country *i* in year *t*; α the country effect; and *e* is the error term. W is a vector of health system variables (*health care spending*, measured by total health expenditure expressed in per capita constant US$ 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 (prevalence of daily *smokers*, *alcohol* consumption in litres per capita, prevalence share of the population having of a daily *vegetable* consumption). Y is a vector of income and other socioeconomic variables (*income* measured by GDP per capita at constant US$ 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 (*air pollution* measured by the share of the population exposed to fine particulates PM2.5). These variables were selected because they reflect the key determinants of health outcomes identified by the literature, and because they are consistent with variables included in previous empirical health production function analyses. These variables were not available for the full time period, and were linearly interpolated to fill in the gaps.

A Cobb-Douglas production function is used, whereby all variables are expressed in logarithmic form. This specification also implies constant returns to scale. The general econometric specification is a GLS model with country fixed effects (specified by country dummies), country-specific autocorrelation structures for errors (AR1), and a correction for heteroscedasticity. Additional empirical models were run to adjust for potential time-specific observed factors (using a time trend variable) and endogeneity (using lagged variables as instruments). Annex 2 has full details on model specifications.

25. The analysis builds on a standard empirical model (Model 1) which contains a set of key determinants of health as described in Box 1. Additional models consider lagged variables (Model 2) and time-effects (Model 3). Notable differences are that the positive impact of health care spending increases when accounting for delayed effect (Model 2); and that the strength and significance of coefficients fell for all variables when introducing a time trend (Model 3). Table 2 shows regression coefficients across these different empirical models (see Annex 2 for further details on these models).

26. Results from Model 1 presented in Table 2 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. Increased out-of-pocket spending has a negative and significant relationship with life expectancy. Increased smoking rates and alcohol use are negatively associated with life expectancy gains. Healthy diet has a positive but not significant association with life expectancy. This may be explained by the difficulty to capture the nutrition effect at the macroeconomic level. Higher long-term unemployment rates were somewhat surprisingly positively associated with life expectancy gains. This surprising result is actually 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). 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 (see details in Annex 2). 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 (see details in Annex 2).

27. Lagged variables in Model 2 aim to capture the delayed effects of the key determinants of life expectancy as identified in the literature. The selected key determinants may influence health both on the short and long-terms, but their effects on life expectancy are more likely to appear on the long run (e.g. time to invest in health and develop heath care services; income and education improve health care access and health-related behaviours with overall long-run effects on life expectancy; lifestyle behaviours and air pollution are major factors of long-term chronic diseases). 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.

28. Results in Model 2 are consistent with Model 1, except that the effects of out-of-pocket spending and unemployment became not significant. One possible explanation for the non-significant associations is possibly the very small variation in these determinants over the time period studied (1990-2010). Model 2 is preferred to Model 1 since it accounts for lagged effects and addresses partly endogenity issues.

29. In Model 3 which accounts for time trend, the effects of three variables became not significant (smoking, alcohol and education). The coefficients for alcohol and education reduced importantly and remained same direction. The coefficient for smoking became positive and non-significant. We explored the reasons for this result, and we observed that breaks in series in the time series for smoking rates in Czech Republic and Ireland importantly contributed to this result. Health spending and income remain positively associated with life expectancy, while the strength of the association is reduced.

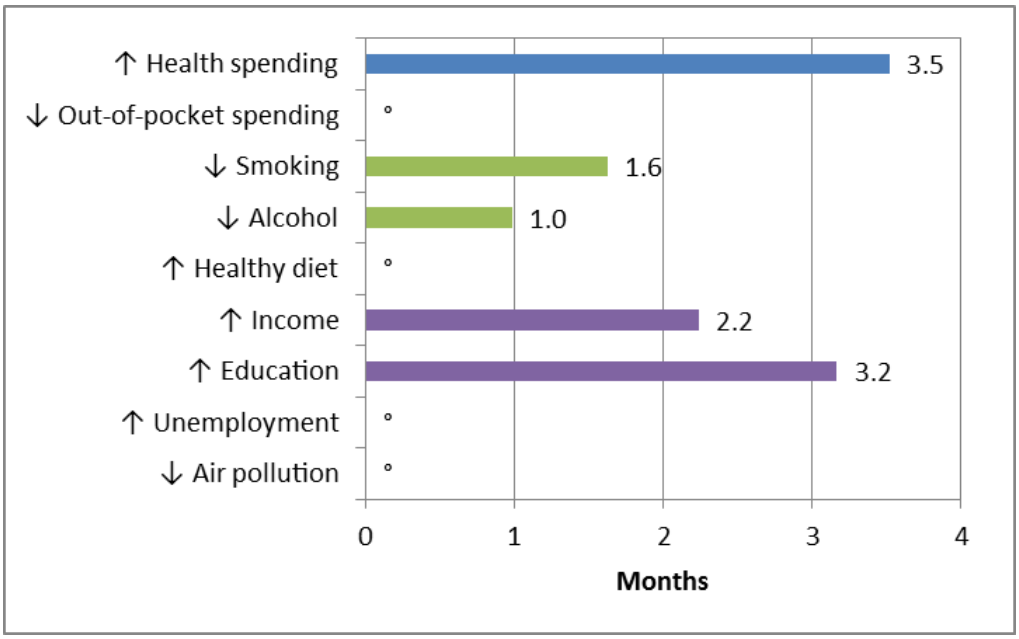
Table 2. Regression coefficients for the analysis of OECD countries, 1990-2015

	Model 1 (standard)	**Model 2** (Model 1 with 5-year lags)	**Model 3** (Model 2 with time trend)
Health sector variables			
Health spending	+ 0.0303**	+ 0.0387**	+ 0.0159*
Out-of-pocket spending	- 0.0027**	-0.0012	0.0008
Lifestyle variables			
Smoking	– 0.0178**	– 0.0179**	0.0034
Alcohol	– 0.0150**	– 0.0108**	-0.0031
Health diet	-0.0022	0.0020	0.0014
Socioeconomic variables			
Income	+ 0.0287**	+ 0.0246**	+ 0.0116**
Education	+ 0.0480**	+ 0.0348**	0.0037
Unemployment	+ 0.0025**	0.0004	-0.0001
Environmental variables			
Air pollution	-0.0003	-0.0003	0.0001
Other variables			
Constant	+ 3.7262**	+ 3.7422**	+ 4.0779**
Time trend			+ 0.0023**
Observations (countries)	893 (35)	718 (35)	718 (35)

Note: on significance level ***p*-value<0.01, **p*-value<0.05. Country fixed effects are not shown.

30. Figure 2 presents the potential gains in life expectancy (expressed in months) associated with a 10% change in the key determinants of health. A 10% increase in health spending 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, and decreased alcohol use with 1.0 month). Wider social determinants also matter. A 10% increase in income is associated with a gain of 2.2 months of life expectancy, and a 10% increase in education with 3.2 months. Surprisingly, air pollution was 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.

Figure 2. Life expectancy gains associated with a 10% change in the main determinants of health. Analysis based on 35 OECD countries for the time period 1995-2015.

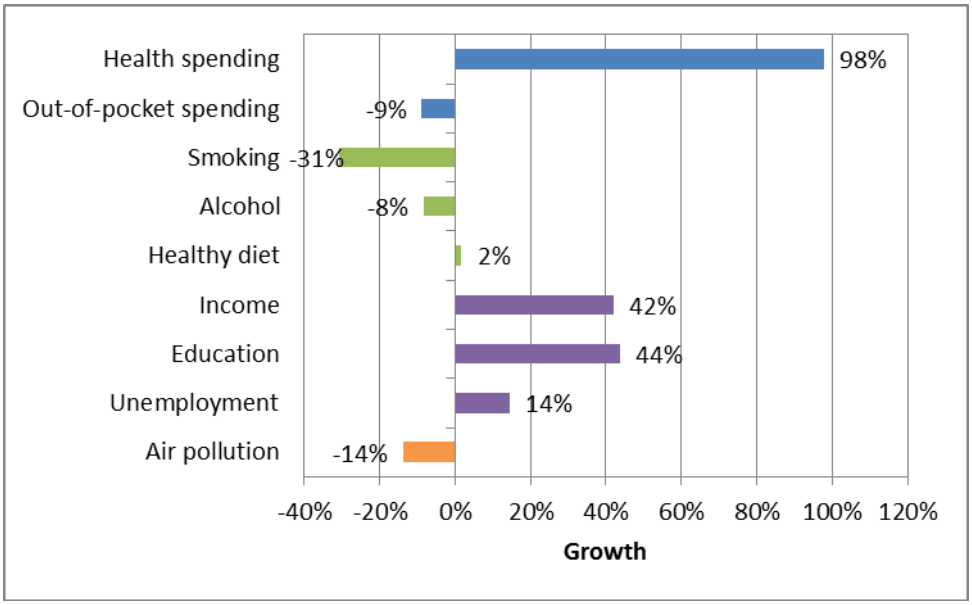


Note: ◦ stands for a contribution near zero.

31. 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 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.

32. Figure 3 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 1624 in 1990 to USD PPP 3212 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 3. Evolution of the main determinants of life expectancy: OECD 1990 to 2010



33. 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 (see Table 3). 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 3 illustrates the relative contributions of each of these determinants, alongside their regression coefficients and values for 1990 and 2010.

Table 3. 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 $ppp)	+ 0.039*	42.4	1 624	3 212
Out-of-pocket spending (as % of health expenditure)	ns	ns	22	20
LIFESTYLE FACTORS				
Smoking (% who are daily smokers)	- 0.018*	5.0	30.3	21.0
Alcohol (litres of pure alcohol per capita)	- 0.011*	0.4	10.1	9.2
Healthy diet (% who are daily consumers of vegetables)	ns	ns	64.2	65.3
INCOME AND OTHER SOCIOECONOMIC FACTORS				
Income (GDP per capita in constant $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.

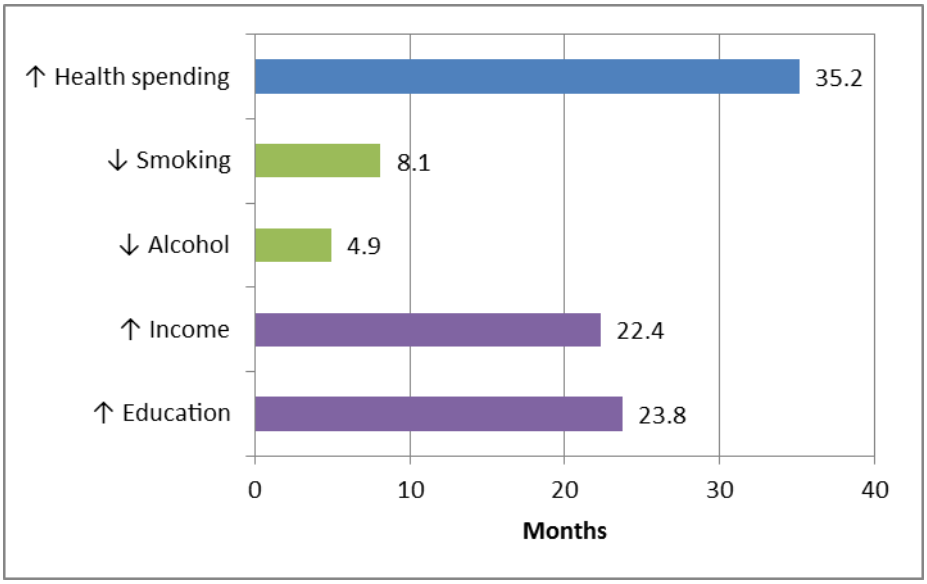
34. Supplementary analyses were carried out to test alternative explanatory variables. We tested a slightly different education variable “having no primary education” but it was not significant. Longer lags (10 years) of the key determinants of health were tested in Model 4 (see Annex 2). Results show that the coefficients of the 10-year lags (Model 4 in Annex 2) are similar to those of the 5-year lags (Model 2) although with less strong association. Using 10-year lags reduce the number of data observations, which may contribute to these weaker associations.

35. Obesity was included as a key determinant in Model 5 (see Annex 2). The association between obesity and life expectancy is positive and significant, which is unexpected. Further analysis showed that the effect of obesity on life expectancy differs at various levels of national income. That is, after a certain level of GDP per capita, the adverse health effects of obesity were found to outweigh the positive health effects of higher GDP (see Annex 2).

36. 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.

37. Policy implications of these findings are important. 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 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).

Figure 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 not significant.

4. From aggregate effects on health status to a social gradient: health inequalities

38. The previous section focused on the relative importance of a range of factors in explaining country-level differences in life expectancy at birth. This is useful in showing the potential health benefit of different inclusive growth policies. However, such health production function analyses can only show aggregate effects of these factors on average health outcomes. That is, these macro-level studies do not analyse the distribution of health across individuals. Such studies also do not explain the underlying reasons why income and other socioeconomic factors should affect health status.

39. An important complement to such macro-level analyses, then, is to assess how and why health status varies across different social groups, based on individual-level data. After briefly discussing health inequality measurement issues, this section provides an overview of the extent of health inequalities across OECD countries and over time. It then outlines the reasons why health status might be better or worse among certain social groups, examining the underlying mechanisms by which different socioeconomic factors can affect an individual's health.

4.1 Health inequalities can be measured across multiple dimensions

40. Measuring health inequalities can be broken down into three general steps: (i) choosing which social groups to compare, (ii) selecting the health indicators to use, and (iii) selecting the methodological approach to quantify the type and extent of inequality. These issues are discussed briefly here (for a more detailed discussion of health inequality measurement, see for example Carr-Hill and Chalmers-Dixon 2005). From an Inclusive Growth perspective, health inequalities associated with socioeconomic group are of particular interest. This includes both economic status (income, wealth) and social position (education,

occupation, employment status).[1] Future analysis should ideally be based on health indicators that adequately reflect the burden of disease.

41. A limiting factor for any analysis of the drivers of health inequalities is data availability. That is, whilst a number of health indicators have been used in health inequality analyses, in practice only a few health indicators have data that are routinely disaggregated by social group across countries and over time. Availability of these indicators is summarised in Table 4.

Table 4: Health variables disaggregated by social group and data availability in OECD countries

Health variable	Data by socioeconomic group widely and routinely available?*	
Mortality and longevity		
Life expectancy	Yes	Life expectancy estimates (at birth, specific ages, by gender) disaggregated by education level are commonly available.
Mortality rates	Yes	General mortality rates (at different ages, by gender) disaggregated by education level are commonly available. This can include summary indices of the dispersion of ages at death.
Morbidity		
Multi-attribute morbidity measures (e.g. EQ5D)	No	In principle, multi-attribute measures disaggregated by socioeconomic group could be included in nationally representative health surveys. However, this is not currently done on a routine basis in OECD countries.
Self-rated morbidity measures	Yes	Measures of self-rated health disaggregated by various socioeconomic factors (including income, education) are available in most OECD countries. Some countries also routinely collect survey data on self-rated disability.
Disease-specific prevalence	No	Some studies have analysed disaggregated prevalence rates by socioeconomic status, but such data are not routinely available in OECD countries.
Composite measures combining mortality and morbidity		
Single health metrics (e.g. DALY, QALY, HALE)	No	Disaggregating these health variables by socioeconomic factors requires linking results to survey or census data (e.g. Charafeddine et al 2011). However, this is not currently done on a routine basis in OECD countries.
Lifestyle and common risk factors		
Tobacco and alcohol consumption, obesity	Yes	Self-reported data on these lifestyle factors, disaggregated by socioeconomic factors, are available every few years in most OECD countries.

*Widely and routinely available refers to nationally representative data that are available for multiple OECD countries over repeated time periods.

42. Different methodological approaches have been used to quantify health inequalities. The simplest approach is pairwise comparisons between different socioeconomic groups (e.g. differences in life expectancy between the highest and lowest income quintile). The main limitation of pairwise comparisons is that only part of the sample is examined. Composite measures make use of all subgroups, although results can be harder to interpret. The Lorenz curve (health inequalities without any socioeconomic breakdown), concentration curves and indexes (relative differences in health by a socioeconomic variable) and the slope index of inequality (absolute differences in health by a socioeconomic variable) are some of the main measures used[2].

[1] As well as socioeconomic groups, two other broad categorisations have been widely used in inequality debates, with individuals compared by *social demography*: demographic (age and gender); socio-demographic (area of residence, ethnicity, family structure) and *social environment*: physical environment (housing conditions, rural versus urban); social capital (social networks / support).

[2] The *Lorenz curve* is the cumulative distribution of an ordered health variable (e.g. life expectancy, self-assessed health). The health *concentration curve* measures relative inequality. It first orders the population by a socioeconomic variable (typically income, wealth or education), then plots this against a health variable. A health *concentration index* provides a quantitative summary of this concentration curve, with a positive value indicating health inequalities favouring more advantaged socioeconomic individuals (for a positive health variable such as life expectancy). The *slope index of inequality* is a regression line showing the absolute effect on a health variable of moving up or down one unit in the socioeconomic scale.

43. Most but not all health inequalities between different social groups are also likely to be inequitable. While the notion of health inequality refers to differences in health status between individuals, not all these inequalities are necessarily unjust. That is, the concept of health inequity is a normative ethical notion about the injustice or unfairness of health distributions. Put another way, the likelihood that certain social groups – the poor, less educated, unemployed, some ethnic groups, those living in deprived physical environments – will be less healthy than others are commonly understood to also be unjust or unfair[3] (see Fleurbaey and Schokkaert 2012 for a more in-depth discussion).

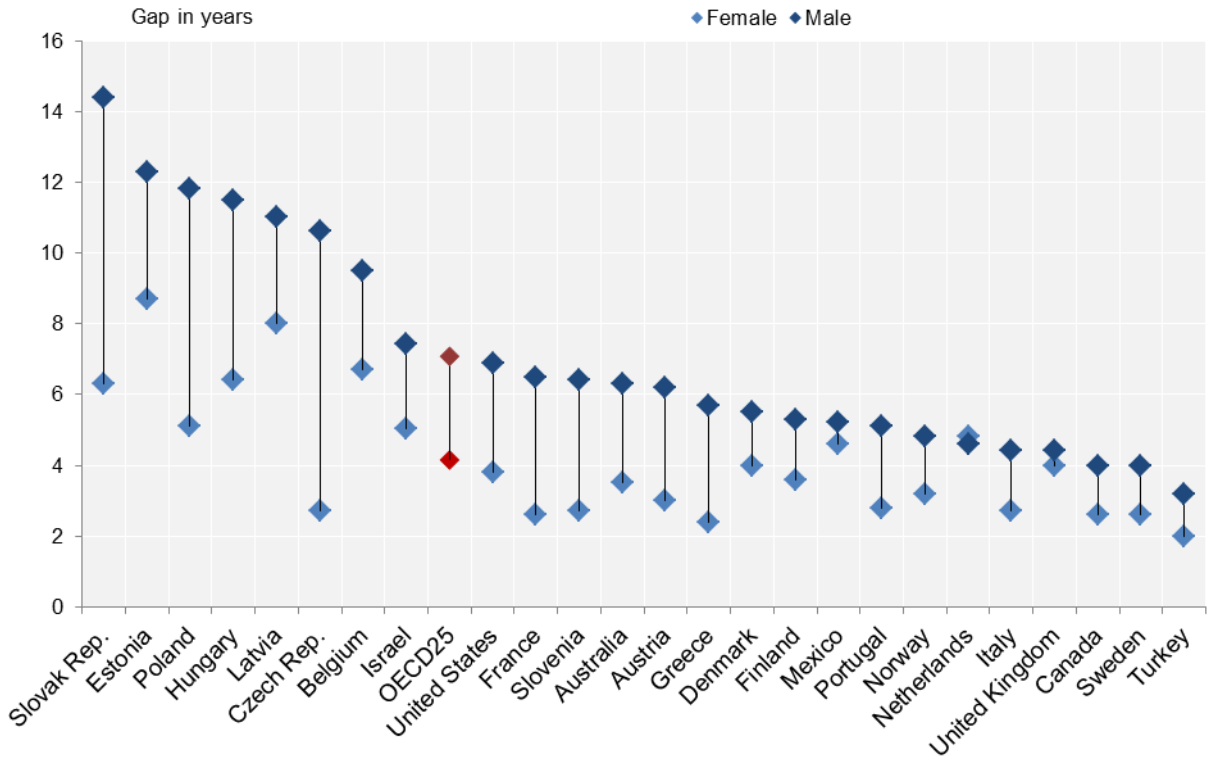
4.2 There are large health inequalities in many OECD countries

Health inequalities today are more marked amongst men than women, and are particularly high in Central and Eastern Europe

44. In many OECD countries, health inequalities by socioeconomic status are substantial. More educated people live considerably longer than those with less education, with differences particularly pronounced for men (Figure 5). On average among 25 OECD countries for which recent data are available, people with the highest level of education can expect to live around six years longer than people with the lowest level of education at age 30 (53 versus 48 years). Health inequalities are higher among men than women in all countries with comparable data. Health inequalities are particularly high amongst men in Central and Eastern Europe, above ten years in the Slovak Republic, Estonia, Poland, Hungary, Latvia and Hungary. In these countries, older people not only have lower levels of education but also studied in the central planning era with competencies that are less suitable for the market economy.

[3] In contrast, the fact that the elderly are, on average, in less good health than young adults reflects a biological reality. Therefore this health difference (inequality) would not typically be seen as being inequitable in itself. The important proviso is that age and gender can be strongly correlated with other social groupings (e.g. income) where health differences are also inequitable.

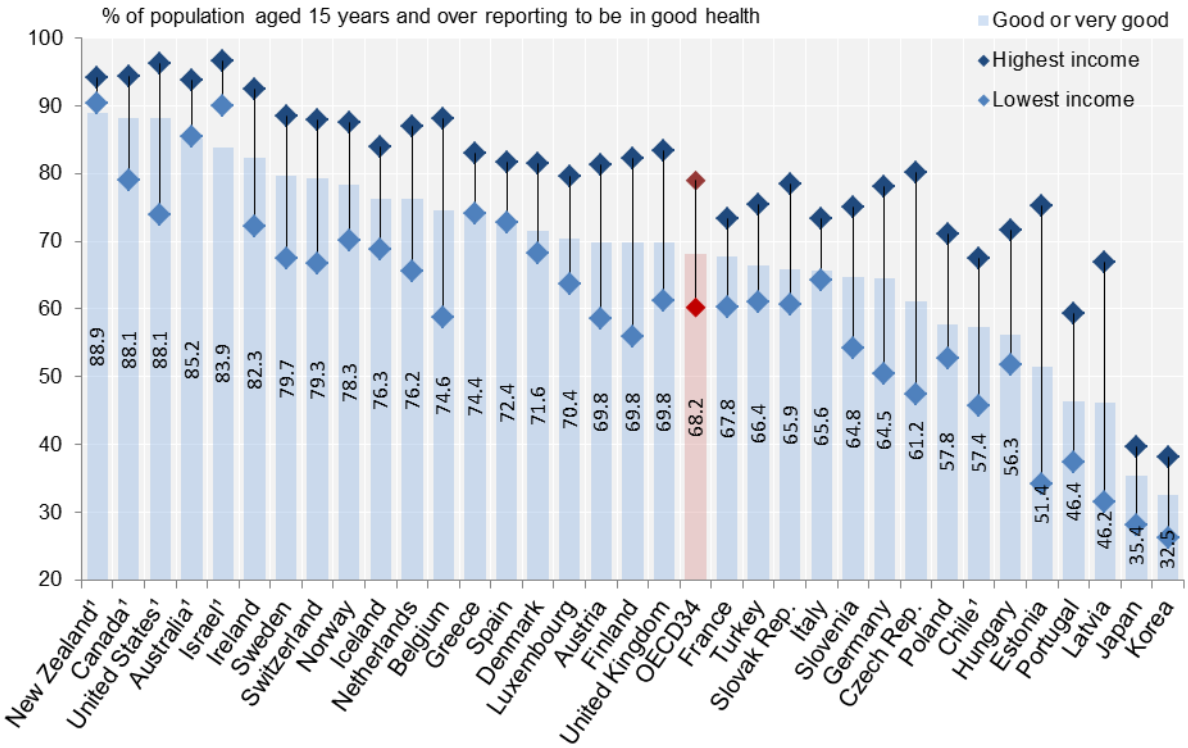
Figure 5. Health inequalities: socioeconomic differences in life expectancy, 2015 (or nearest year)



Source: OECD Health Statistics (reproduced from OECD Health at a Glance 2017)

45. Large health inequalities are also evident when considering morbidity, as measured for example by differences in self-reported health (Figure 6). On average across OECD countries, nearly 80% of people in the highest income quintile report being in good health, compared with just over 60% for people in the lowest income group. These disparities may be explained by differences in living and working conditions, as well as differences in smoking and other risk factors. People in low-income households may also have limited access to certain health services for financial or other reasons (see Chapter 5 on "Access to care"). A reverse causal link is also possible, with poor health status leading to lower employment and lower income. Inequalities in self-reported health by income level are especially high in Estonia, Latvia and the Czech Republic, where the difference in self-reported heath between individuals reporting different income is over 30 percentage points.

Figure 6. Health inequalities: socioeconomic differences in self-reported health, 2015 (or nearest year)



Source: OECD Health Statistics (reproduced from OECD Health at a Glance 2017)

Source: OECD Health Statistics, http://www.oecd.org/els/health-systems/health-data.htm

4.3 Decomposition analyses shed some light on the relative contributions of different socioeconomic factors in explaining health inequalities

46. A number of studies have tried to quantify the relative contributions of different socioeconomic factors in explaining health inequalities by using ‘decomposition’ methods (see O’Donnell et al 2012 for a discussion on methodologies). Based on survey data, this approach decomposes a summary health inequality measure – the health concentration index – into each of its contributing factors. Such studies have typically focused on health inequalities related to income. A key reason for this is to decompose income-related inequalities in health (IRHI) into that part that can be explained by income itself, and the part of IRHI explained by differences in demographics, or other socioeconomic factors such as unemployment. The health status variable used in these analyses has typically been self-assessed health.

47. Notwithstanding important differences in empirical specifications, some common findings emerge from these decomposition analyses. First, income is the major socioeconomic factor explaining IRHI in most countries analysed, even after controlling for other factors. For example, van Doorslaer and Koolman found that income itself accounted for 25-40% of income-related health inequalities in 13 of 14 EU countries studied (van Doorslaer and Koolman 2004). Using more recent data, Asgeirsdottir and Ragnarsdottir reported broadly consistent findings. They found income to be the main socioeconomic factor explaining IRHI in 21 of 26 European countries, though with much greater variability (Asgeirsdottir and Ragnarsdottir 2013). In North America, McGrail et al found income itself accounted for close to 50% of IRHI in Canada and the United States (McGrail et al 2009).

48. Nevertheless, a large portion of income-related health inequalities are not associated with income alone. Education also explains an important part of IRHI. The van Doorslaer and Koolman study found that IRHI would have been 9-24% lower if everyone had the same education level. Asgeirsdottir and Ragnarsdottir also conclude that education was typically the second most important socioeconomic factor explaining IRHI, and the most important in 4 European countries. A number of individual country studies found broadly comparable results. For the UK, Costa-Font et al. (2011) found that education explained 20-27% of IRHI between 1997 and 2007; similar contributions were observed in Belgium (Lecluyse 2007) and Turkey (Sozmen and Unal 2014).

49. The contribution of occupational status to IRHI varies considerably across countries. This could reflect differences in social protection schemes as well as economic conditions. The van Doorslaer and Koolman study found that being economically inactive was an important factor contributing to IRHI in the Netherlands, UK, Ireland and Spain, but less so elsewhere. Kachi et al. (2013) conclude that occupational status is a particularly important factor in Japan, noting that the relative contribution of unemployment to IRHI increased significantly over time, reflecting periods of substantial economic downturns. From 1986 to 2007, being unemployed or economically inactive increased from 18% to 77% for men and from 10% to 31% for women.

5. The importance of policies affecting income, employment, education and living conditions in reducing health inequalities, alongside more health sector-specific policies

50. Understanding why such health inequalities persist in most OECD countries is central to policy. This requires a closer analysis of exactly how income, occupational status, education and other factors affect health outcomes.

5.1 The nature of income trajectories matter: persistent poverty has particularly adverse health effects; falls in income have a larger impact on health status than income gains

51. The positive association between an individual's own income and health status is an important general finding from existing research. But examining how different income trajectories influence health status can provide further insights for policymakers[4]. A first observation is the *importance of minimum absolute levels of income*. Whereas low income and poverty have a clear detrimental effect on health status, health differences between individuals with average or high income are far less pronounced (Deaton 2003). That is, there is a non-linear relationship between income and health.

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

53. Third, *income reductions generally seem to have a larger impact on health status than income gains* (irrespective of whether they are temporary or more permanent). Sudden income losses can cause immediate and substantial declines in mental health, possibly due to enforced changes in housing and other stressful life events. For example, McInerney et al (2013) found that income 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 sample studied. In Sweden, self-assessed health responded to decreases in income to a greater extent than to income gains over time (Miething and Yngwe 2014). Similarly, most (but not all) studies of sudden wealth gains from inheritance,

[4] This sub-section on income trajectories draws significantly from the excellent review of O'Donnell et al (2013).

stock market and lotteries find limited or no evidence of associated improvements in health status (O'Donnell et al 2013).

54. Indeed, *receipt of welfare and social security benefits can trigger adverse health events in some circumstances*. This could reflect an increase in more risky behaviour. 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. Still, such evidence of adverse health effects from income payment remains relatively uncommon.

55. A policy implication from these findings is that *progressive policies on taxation, benefits and minimum wages* are likely to contribute to improved health outcomes for most people on low incomes. At the same time, policies providing more targeted material support can be complementary. For example, studies of the Supplemental Nutrition Assistance Program, which provides food vouchers to low-income families in the United States, find evidence of positive impacts on birth outcomes and child health (US Executive Office of the President 2015).

5.2 Unemployment worsens mental and physical health; employment conditions also matter

56. In terms of labour force status, *being unemployed adversely affects both mental and physical health*. 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 is also associated with lower use of health services, with consequent effects on health status (van Gool and Pearson 2014). For example, Lusardi et al (2010) found unemployment to be negatively associated with routine health care use in all countries studied (Canada, France, Germany, the United Kingdom and the United States); while Tefft and Kageleiry (2014) noted that unemployment reduced the use of preventive services. In contrast, aggregate-level studies have typically shown better health outcomes when unemployment rates are high – but this likely reflects factors such as fewer traffic accidents and less pollution rather than unemployment in itself (as discussed in Section 3).

57. Unemployment also affects mental health. The psycho-social literature suggests that this mainly reflects reduced social contact, a less defined social identity and losing an ordered structure to daily living (Clark 2003). Such insights are backed up by evidence from panel-data. For example, in Australia, Canada and the United Kingdom, evidence from panel data shows that moving from employment to unemployment significantly increased mental distress (Llena-Nozal 2009).

58. The adverse effect of unemployment on mental health suggests that cash payments will not be sufficient to protect unemployed peoples' health. Alongside better system-wide mental health policies, *targeted mental health services for the unemployed* can help. In Belgium, for example, the Flemish Public Employment Service funds a special programme developed in cooperation with the mental health and welfare sectors. Designed for jobseekers with severe psychological and psychiatric problems, this programme showed positive health responses with increases screening and improved employment outcomes (OECD 2015e).

59. *Employment conditions also matter*. First, working longer hours is harmful to health. Longer hours not only raises general stress levels, but there is strong evidence that it also increases 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).

60. Second, choice over working hours is crucial, irrespective of the number of hours worked (Bassanini and Caroli 2014). That is, the extent to which employees have control over hours worked or their work schedule affects their health. For example, Dockery 2006 found that people in Australia working longer hours than they wished experience lower mental health, even if they only worked part-time; whilst also finding worse mental health amongst those working less than they wished. At the same time, people forced to delay retirement had a higher risk of depression, while those choosing to retire early reported positive health effects (Bassanini and Caroli 2014).

61. Other aspects of job quality are also important. Low-status workers often have to operate in less safe working environments. In particular, exposure to hazardous substances and risk of injury is typically concentrated amongst low-skilled menial labour (Clougherty et al 2013). Job insecurity is also an important factor. For example, a cross-country survey of 22 European countries found that the fear of losing one's job worsened health in terms of headaches and other measures of stress (Caroli and Godard 2013). More generally, mental health and job satisfaction are highly correlated (see, for example, Datta Gupta and Kristensen 2008).

62. A number of employers in OECD countries have introduced *policies to increase employee participation and choice*, with the aim of reducing absenteeism, including the additional benefit of better employee health. For example, in Germany, the introduction of self-scheduling by bus drivers contributed to a 20% reduction in traffic accidents (Gauderer and Knauth 2004). More generally, a review of workplace interventions spanning Canada, Japan, the Netherlands, Sweden, the United Kingdom and the United States found that policies which improved employee control had positive mental health effects (Egan et al 2007).

5.3 Education encourages more healthy behaviours

63. 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, and better able to process and act upon this information*. For example, people with lower education levels are more likely to smoke, be obese and less physically active, across many OECD countries (Cutler and Lleras-Muney 2010, Mackenbach et al 2008). Further, for obesity the relative level of education appears to be more important than absolute differences. This may suggest that more targeted education efforts are likely to be more effective in reducing obesity (Devaux et al 2011). The evidence on alcohol, however, is more mixed. A recent OECD report found that better educated women were more likely to drink excessively, though the opposite held true for men (notwithstanding important cross-country variation) (OECD 2015d).

64. Better educated people are also *more knowledgeable about exactly which health services are available* to them, which can translate into 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 efficiency) of medical treatment, particularly for chronic diseases. This insight is based largely on the influential study by Goldman and Smith 2002, who reported that more educated diabetic and HIV patients had higher adherence to treatment and maintained a better health regimen. However, Maitra (2010) revisited the data and found that the impact of self-management, though relevant, may have been overstated.

65. What is less clear from the evidence is what type of education is most important for health status. Most studies have not analysed the impact of different fields of study, and have focused on the impact of primary, secondary and tertiary education (OECD 2006). One example of a study on learning in later life

found that participation in adult learning significantly increased the chance of taking exercise (Feinstein and Hammond 2004).

5.4 Low-income households and ethnic minorities are more likely to experience inadequate living conditions with consequent effects on health status

66. A person's living environment can be a crucial determinant of health. *Poor housing conditions* (e.g. cold and damp, inadequate safety) 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.

67. Policies aimed at improving these living conditions have been effective in improving health outcomes. For example, in the United Kingdom, Sure Start local programmes provided integrated support to young children and their families in disadvantaged areas, in terms of early education, childcare and family support services as well as healthcare – with positive health effects on children (NESS 2010). Across a number of OECD countries, policies targeting better housing infrastructure (home visits, removal of hazards) and rental assistance policies, have also had positive health effects (Bambra et al 2010).

68. The Moving to Opportunity (MTO) Programme, in five US cities, adopted a more radical policy, supporting very low-income households to move from poverty-stricken urban areas to lower poverty neighbourhoods. Girls in the MTO programme reported better mental health and engaged in less risky behaviour than matched girls remaining in high-poverty neighbourhoods (Leventhal and Dupere 2011). Whilst such a policy appeared effective, the feasibility of scaling up seems limited.

69. Indeed, living in a materially less-well off neighbourhood does not have to predetermine a greater risk of adverse health outcomes. An important factor is the degree of 'social capital' in the neighbourhood, i.e. the social networks within communities that provide mutual support and cooperation to residents. *Social capital can encourage the diffusion of health information and healthy behavioural norms, as well as offer psychosocial support* (OECD 2010b).

70. Initiatives that have made use of these social networks have been effective in improving health information campaigns and healthy behaviours. For example, Viswanath et al (2006) found that in Minnesota in the United States, a higher level of civic engagement through ties to community groups was associated with better recall of health messages. Hovell et al (2008) found significant improvements in cardiorespiratory fitness for overweight Hispanic immigrant women in the United States when aerobic classes in Spanish were set up near their community clinic. In London, a Ramadan linked campaign had a higher success rate for smokers trying to give up, as compared with previous attempts (Taket et al 2003).

71. *Environmental pollution also varies greatly across different neighbourhoods*, with consequent effects on health. A review found that whilst poorer and less educated populations often (but not always) lived in areas with worse air pollution, they 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.

72. Finally, although most OECD countries have universal health systems, populations living in certain neighbourhoods still often have worse access to health services. Alongside greater investment in the supply of health providers in such neighbourhoods, specialist outreach programmes that take into account cultural barriers can help equalise access. For example, the Specialist Outreach Service to remote

Aboriginal communities in the Northern Territory of Australia has improved access for this specific population group (Gruen and Bailie 2004).

6. The impact of better health outcomes on the wider economy

73. Previous sections examined how income and other socioeconomic factors affect health and health inequalities. This section[5] examines the other side of the relationship: how health outcomes affect the wider economy. Evidence on the impact of health on schooling and work outcomes are discussed, along with benefits that extend beyond the individual.

6.1 Children in good health do better at school

Ill-health in early life can hinder cognitive development

74. Infant malnutrition and childhood diseases have lasting impacts on cognitive development. Some of the most important risks include stunting, anaemia, iron, iodine and zinc deficiencies (Nyaradi et al 2013). Malnourished children also tend to score lower on tests of cognitive function, have poorer motor skills and psychomotor development. They also interact less frequently with their environment and are less successful in acquiring skills at normal rates (López-Casasnovas et al., 2005).

75. For example, three meta-analyses found that iodine deficiency in children compromised intelligence quotient (IQ) by 8 to 13.5 IQ points (Bougma et al 2013). Interventions that provide iodine to pregnant women may reduce this gap, but provision to school-aged children does not seem to reverse former damage (Grantham-McGregor et al 2007). Further, anaemia may affect schooling results independently of earlier impaired brain development. Given that more than 40% of children under 4 years old from developing countries are affected by anaemia, addressing this problem is particularly important to improve schooling outcomes (Alderman et al 2005). Consequently, improving nutritional intake of young infants is likely to confer substantive benefits over an individual's lifetime.

Ill-health in children and adolescents worsens educational outcomes

76. Children and adolescents with poor health have worse educational outcomes, as they are more often absent from school, and more likely to drop out of school altogether. In developing countries, various infectious diseases have particularly adverse effects, with malaria and worm infections two notable examples. For instance, in Kenya randomised evaluations of intermittent preventive treatment of malaria (Clarke et al 2008) and deworming drugs (Miguel and Kremer 2005; Aiken et al 2015) found improved cognitive ability and reduced absenteeism among schoolchildren.

77. In high-income countries, sleep disorders and mental health problems are common health conditions that impact future developmental outcomes for children and adolescents (Suhrcke and de Paz Nieves 2011). For example, shortened sleep duration, especially amongst young infants, is associated with hyperactivity-impulsivity and poor test results in cognitive performance (Touchette et al. 2007). Studies focusing on mental health problems show that anxiety and depression are significantly and negatively associated with short and long term educational outcomes (Mazzone et al. 2007; Spernak et al. 2006).

[5] This section is largely drawn from James (2016).

6.2 Adults in good health are more productive

People in ill-health are more likely to be unemployed, are less productive when they do work and earn less

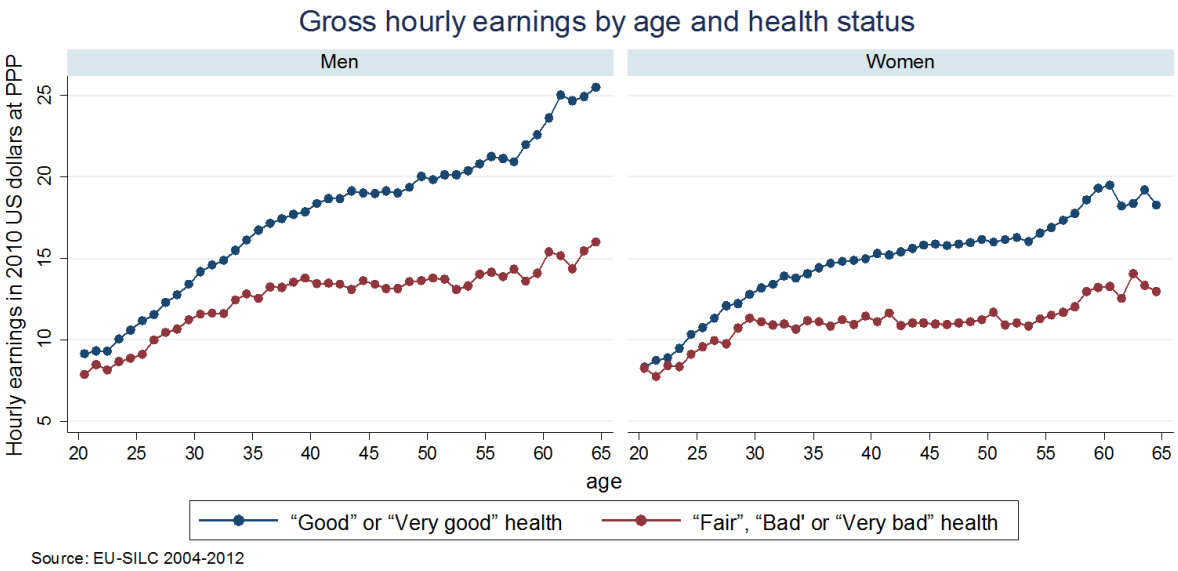
78. Adults in ill-health are more likely to be unemployed, and when they have a job are more likely to be absent from work and less productive at work. Older adults with chronic diseases and other health conditions are at greater risk of quitting the workforce prematurely.

79. First, being in ill-health adversely affects one's employment prospects. For example, unemployed people in Great Britain are almost twice as likely to have a long-standing illness or disability (UK Office for National Statistics, 2012). Moreover, being unemployed is likely to further worsen an individual's health, implying a self-perpetuating cycle between ill-health and unemployment.

80. For those who are employed, absence from work due to illness can also be substantial. Across 15 OECD countries, an average of 11 days were lost per worker in 2013. Rates were particularly high in Germany (18) and Norway (16), equivalent to approximately 7.2 million working days lost in Germany and 0.42 million working days lost in Norway (OECD Health Statistics). In addition, some workers in a poor health condition may still go to work – commonly referred to as presenteeism – but at the costs of lower productivity and of a further deterioration of their health. For example, presenteeism at work was estimated to have cost the US economy $150 billion a year (Hemp 2004).

81. Individuals with poor health status also have lower wages at all ages, with the wage gap expanding over the life-course. For example, in 21 European countries the gap in hourly earnings reached almost 10 USD PPP for older male workers (Boulhol, Scarpetta et al (2015), Figure 7).

Figure 7. Individuals in ill-health have lower wages



Source: Boulhol, Scarpetta et al (2015). Generation next: how to prevent ageing unequally. OECD ELS Committee Paper 2015/25.

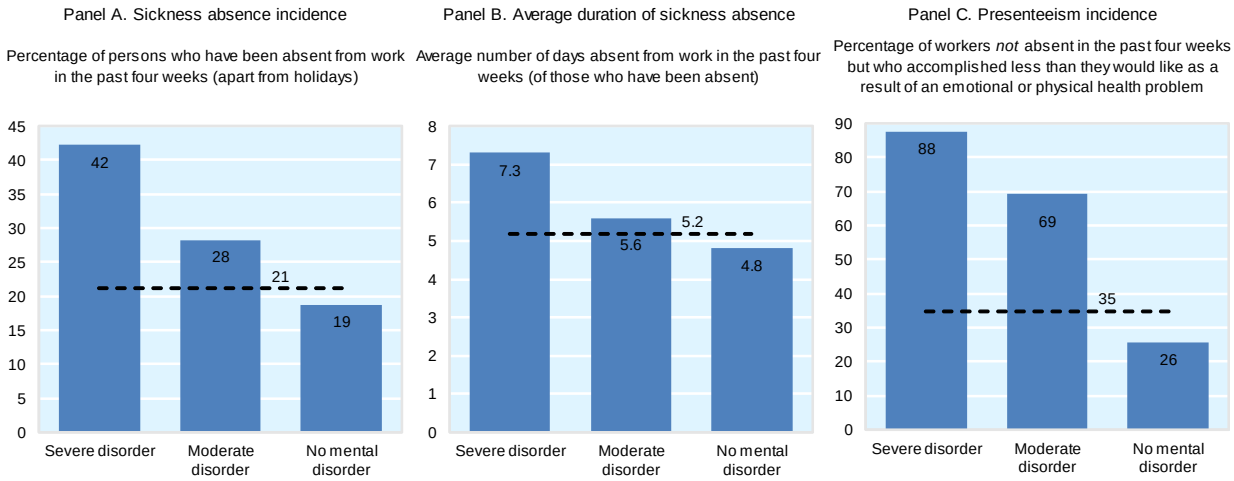
Mental ill-health, chronic diseases and poor lifestyles are key drivers of labour productivity losses in OECD countries

82. Mental ill-health is an important cause of absenteeism and presenteeism in OECD countries. This is because the effects of mental illness fall mainly on people during their working lives, as opposed to the burden of most other non-communicable diseases which commonly affect older individuals. There is also the indirect effect of increased presenteeism, absenteeism and unemployment amongst the carers of individuals with mental disorders.

83. In terms of magnitude, European data suggest that the incidence of sickness absences is roughly double for workers with severe mental health problems, and 50% higher for those with moderate problems, compared to those with no mental health problems. Absence duration is also longer for those with mental health problems. Strikingly, very high proportions of workers with mental health problems who do not take sick leave find themselves in a situation where they accomplish less than they would like, due to their health problems (Figure 8).

Figure 8: Absenteeism and presenteeism both increase sharply with poorer mental health

Incidence of absenteeism and presenteeism (in %) and average absence duration (in days), by mental health status, average over 21 European OECD countries in 2010



Source: OECD (2012), *Sick on the Job? Myths and Realities about Mental Health and Work* (Figure 2.19; OECD compilation based on Eurobarometer 2010).

84. The poor labour productivity of people with mental health problems is worrying because such problems are highly prevalent: at any moment in time, one in five people suffer from a mental illness which will often be chronic or recurring. This implies massive impact on an aggregate level. Moreover, the incidence of presenteeism seems to have increased in the recent past; which might be a contributing factor to the observed productivity slow-down (OECD, 2012).

85. Chronic diseases and poor lifestyles can also lower workers' productivity, and harm their employment prospects and wages. For example, in France the overall production losses related to alcohol use and smoking have been estimated at 9 and 8.6 billion Euros respectively (Kopp, 2015). In Germany, sickness absence and enforced early retirement due to smoking cost an estimated 4.9 and 3.5 billion Euros respectively (Welte et al 2000). In the United Kingdom, nearly 11 million working days were lost by alcohol-dependent workers in 2001, and the total cost of absenteeism due to alcohol was estimated to be

£1.2 billion (UK Cabinet Office, 2003). In the European Union, alcohol accounted for an estimated €59 billion worth of lost production through absenteeism, unemployment and lost working years through premature death in 2003 (Anderson and Baumberg, 2006).

86. As well as smoking and alcohol, obesity and diabetes also affect labour market outcomes. For instance, diabetes is significantly associated with a 30% increase in the rate of labour-force exit across 16 countries studied (Rumball-Smith et al, 2014). The cost of obesity for sick-leave and disability pension in the Swedish female population was estimated at 10.5 billion SEK (USD 1.2 billion) per year (Narbro et al, 1996). For developing countries, in addition to mental ill-health, chronic diseases and poor lifestyles, infectious diseases have a major impact on labour markets, with the HIV/AIDS epidemic particularly substantial (Box 2).

Box 2: The labour force impact of HIV/AIDS in low- and middle-income countries

The HIV/AIDS epidemic has a large impact on labour markets in many low- and middle-income countries, particularly in Sub-Saharan Africa. HIV/AIDS limits African countries' productive capacity by damaging human capital development and decreasing the possibility to find a job. Studies from South Africa found that being HIV-positive increases the likelihood of unemployment by 6-7%. These constraints become even more relevant for those less educated and who are disadvantaged (World Bank 2014, Health Status, Health Regulations, and Labor Markets).

6.3 Good health has wider economic benefits that go beyond the individual

87. Good health also has wider benefits beyond the individual, particularly in developing country contexts. Better population health can encourage greater domestic savings, foreign investment and improve social stability (Murtin 2015). Better health prospects also encourage investment in human capital, and via this channel enhanced economic growth (Cohen and Soto 2007). In countries with high fertility rates, a reduced likelihood of premature mortality can also positively influence household decisions on family planning. This contributes to a faster demographic transition and its associated economic benefits.

88. In all countries, poor health affects people's ability and motivation to save. However, the impact is larger in low and middle-income countries that are still transitioning to universal health coverage. In such countries, incomplete prepayment systems mean that households will often have to pay out-of-pocket for needed health services. This can lead to severe financial hardship and impoverishment (WHO 2010).

89. Better population health can also raise income per capita by changing decisions about expenditures, savings and investment. With increased longevity and the associated greater prospect of retirement, new generations have greater incentives to save. At the same time, companies tend to invest in economies where the workforce is healthy, and move away from environments with high burdens of disease (López-Casasnovas et al., 2005).

90. The prospect of better health outcomes will also impact family planning and consequently fertility rates. This can create a 'demographic dividend' of a lower dependency ratio. That is, as fertility begins to slow, the number of children shrinks and proportion of working-age people increases. This creates a favourable situation of more workers supporting fewer dependents, which is positive for economic growth. Many Asian and Latin American countries have already achieved this, and there are indications that some African countries (e.g. Rwanda and Ethiopia) are beginning to follow. However, a demographic dividend does not automatically follow from lower fertility rates and requires investment in other areas such as girl's education and good governance to be achieved (Gribble and Bremner, 2012). Such factors are also relevant in more advanced economies.

91. Taken together, these factors show how better health can have substantial impacts on economic growth and development; although the exact strength of this effect remains a matter of debate (see Murtin 2015 for a detailed discussion on the related econometric literature).

7. Conclusions

92. Whilst economic growth is important, it is not sufficient by itself to generate sustained improvements in living standards that are shared across a society. This paper has shown that health is a critical component of inclusive growth, both as a major dimension of well-being in itself and because of its two-way relationship with income, employment and other key aspects of living standards.

93. 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 health spending over the past 20 years, higher health spending is associated with 42.4 months of life expectancy gains in this time period. Health spending accounts for both curative and preventive health care. Expenditure on prevention can have major effects on reducing lifestyle risk factors and preventing diseases, with delayed effects while preventive measures are incurred several years before. Still, prevention accounts only for a minor part of total healthcare expenditure (around 3%).

94. 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, as well as the fact that there have only been limited improvements in these factors over time.

95. 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.

96. It is important, though, to reiterate that observed associations between life expectancy and explanatory factors at this macro-level does not guarantee causality. 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.

97. At the same time, better health is central to the effective functioning of a country's economy, today and in the future. Healthy children do better at school; healthy adults are more productive at work and less likely to be unemployed. Good health also has wider economic benefits beyond the individual, contributing to better social stability, domestic savings and foreign investment. Particular attention should be paid to early childhood, since early life circumstances are crucial to future health and economic

circumstances. That is, without policy interventions, health and other inequalities are likely to persist over generations.

98. Improving health outcomes and reducing health inequalities requires coordinated action by ministries responsible for housing, education, 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). Partnerships with the private sector will also be important, especially in relation to working conditions.

99. Better understanding the inter-linkages between health and the wider economy is an important step to improving health and economic outcomes for all. This paper has contributed to understanding these inter-linkages – further analyses can build on these insights. Future work could explore alternative dependent variable specifications, include variables that proxy health policies and institutional characteristics, and sub-national analysis. Further assessment of inter-generational effects could also provide value, particularly given concerns on health inequalities persisting over the life-cycle. Together with the findings in this paper, such analyses can help governments find ways to improve health outcomes and make economic growth more inclusive.

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ANNEX 1 – CROSS-COUNTRY HEALTH PRODUCTION FUNCTION ANALYSES

100. To construct Table A1 in the main text, a systematic review of the empirical health production function literature was conducted. The Econlit, PubMed and Scopus databases were searched in August 2015, based on the following search strategy:

- *Search terms*: (Regression Analysis OR Econometrics) AND (Health Resources OR Health Expenditures) AND (health production function OR determinants of health OR determinants of mortality OR determinants of life expectancy OR health outcome)

- *Inclusion/exclusion criteria*: only studies from 1995 onwards were included. Studies that did not include OECD and/or BRIICS countries in their analyses were excluded. Studies that did not differentiate the separate coefficients of individual explanatory factors were also excluded.

101. Table A1 on the following page provides a summary of the main findings for each of these studies included in the literature review.

Table A1: Empirical health production function analyses (macro-level data)

a) Cross-country studies of OECD countries

Authors	Data and methods	Dependent variables	Main explanatory variables	Main results
Asiskovitch (2010)	• 19 OECD countries • Period: 1990-2005 • Panel data regressions	Life expectancy at birth and at age 65	• Health spending (public and private, as % of GDP) • Smoking prevalence; overweight prevalence; nitrogen oxide emissions • GDP per capita; social expenditure, education level	Health spending has a marginal impact on LEs at birth, but a greater impact on LEs at 65 (for both genders). Public funding has a greater effect than private. The findings that men benefit more from access to medical services might be the result of the variables controlled in the analysis.
Berger & Messer (2002)	• 20 OECD countries • Period: 1960-92 • Panel data regressions	Mortality rates	• Health spending per capita; share of public spending; insurance coverage for inpatient and ambulatory care • Tobacco, alcohol and fat consumption • Income; income distribution; age structure; education	Increases in health expenditure are associated with lower mortality, as are healthier lifestyles, higher education. Income inequality does not play a role. Increases in the publicly financed share of health spending are associated with higher mortality rates. Increased insurance coverage for ambulatory care reduces mortality rates.
Blazquez-Fernandez (2013)	• 9 European countries • Period: 1995-2010 • Panel data regressions	Life expectancy, infant mortality	• Pharmaceutical and other non-durables per capita; antibacterial consumption • Alcohol, diet • GDP per capita, % of population who are civilian employees	Pharmaceutical expenditure and drug consumption produce better health outcomes. Alcohol and fruit and vegetable consumption have the expected effect on health.
Elola et al. (1995)	• 17 European countries • Cross-sectional	Life expectancy and premature mortality (PYLL); infant mortality	• Health spending per capita; type of health system (social security versus integrated national health service) • GDP per capita	Health spending may explain more variance in infant mortality than GDP per capita. Income distribution is not an explanatory variable for variations in health. Countries with national health services are more efficient at producing lower infant mortality rates than those with social security systems.
Heijink et al. (2012)	• 14 OECD countries • Period: 1996-2006 • Panel data regressions	Avoidable mortality	• Health spending per capita • Alcohol and tobacco consumption • Age structure, residual mortality • Education, other spending, unemployment	Most countries with above-average health spending growth demonstrated above-average reductions in avoidable mortality. Macro-level healthcare spending increases provided value for money in countries studied.

Nixon & Ullman (2006)	• 15 EU countries • Period: 1980-95 • Panel data regressions	Life expectancy at birth and infant mortality	• Health spending per capita, as share of GDP; number of physicians and hospital beds; inpatient admission rate, average length of stay; insurance coverage • Alcohol, tobacco, diet; pollution • Unemployment rate	Increases in health expenditure are significantly associated with large improvements in infant mortality but only marginally in relation to life expectancy.
Or (2000)	• 21 OECD countries • Period: 1970-1992 • Panel data regressions	Premature mortality	• Total health spending per capita; share of public spending • GDP per capita; occupation • Alcohol, tobacco, diet	Significant positive relation between health expenditure and health, particularly for women. Public health financing also has a positive effect on health outcomes. Environmental factors are more important than medical inputs in explaining variations in premature mortality, particularly occupational status.
Or (2001)	• 21 OECD countries • Period: 1970-1995 • Panel data regressions	Mortality (infant, perinatal mortality, PYLL); Life expectancy at age 65	• Number of doctors, public vs private financing, institutional variables • Alcohol and tobacco consumption • GDP per capita, occupational status, air pollution	More doctors per capita is associated with better health outcomes. A high share of public financing is associated with lower premature, infant and perinatal mortality but does not affect LE at 65 or heart diseases. Institutional variables are often not significant, with some exceptions: countries with fee-for service at the hospital level tend to have lower premature mortality.
Or et al. (2005)	• 21 OECD countries • Period: 1970-1998 • Panel data regressions	Life expectancy at birth and at 65, premature mortality from heart diseases, infant mortality rate	• Number of doctors and medical equipment; public spending share; provider payment; systems in the hospital and ambulatory sectors; gate-keeping role of physicians • Alcohol and tobacco consumption • GDP per capita; education	The impact of health care varies significantly across countries. The public/private mix of health spending and gate-keeping do not play a significant role.
OECD (2010a)	• OECD countries • Period: 1991-2003 • Panel data regressions	Life expectancy at birth and age 65; decline in infant mortality rate	• Health spending per capita • Smoking, alcohol, diet, nitrogen oxides • GDP per capita, education	Health care spending largely drives changes, and cross-country differences, in health status, though other factors also play important roles.
Shaw et al. (2005)	• 29 OECD countries • Period: 1960-1999 • Panel data regressions	Life expectancy at age 40, 60, 65	• Health spending, pharmaceutical expenditure (per capita) • Alcohol, smoking, diet • GDP per capita; age distribution	Pharmaceutical consumption has a positive effect on life expectancy at middle and advanced ages but is sensitive to the age distribution of a given country. Lifestyle factors have important health effects.

b) Global analyses including low or middle-income countries as well as high-income countries

Authors	Data and methods	Dependent variables	Main explanatory variables	Main results
Bokhari et al. (2007)	• 127 countries • Period: 2000 • Cross-sectional	Under-5 and maternal mortality	• Public health spending; donor funding per capita for health • GDP per capita; education and literacy • Paved roads per unit area; sanitation	Economic growth is an important contributor to health outcomes, but government spending on health is just as important.
Cornia et al. (2009)	• 97 countries • Period: 1960-2005 • Panel data regressions	Life expectancy at birth	• Physicians per capita; DPT immunisation • GDP per capita, volatility of GDP, GINI coefficient; Education and female literacy • Alcohol, smoking • Fertility, migration; HIV/AIDS, disaster, war	Slowdown in pace of progress of life expectancy gains during 1980-2000 attributed to rising inequality and volatility, declining health expenditure, lower vaccination coverage, slowly improving female literacy, amongst other factors.
Lin (2011)	• 8 Asian countries • Period: 1976-2003 • Panel data regressions	Mortality rates (all causes, cardiovascular diseases), motor vehicle accidents and suicides	• Number of physicians and hospital beds per 10 000 population • GDP per capita, unemployment rate • Demographics (age, gender), urbanisation	Unemployment rate is negatively and significantly correlated with total mortality. Has a stronger immediate and contemporaneous, rather than a sustained, effect on mortality rates. Socioeconomic factors such as age and gender also play important roles.
Moreno-Serra & Smith (2015)	• 153 countries • Period: 1995-2008 • Panel data regressions	Under-5 and adult mortality	• Health spending per capita (public, voluntary health insurance, out-of-pocket) • Immunization coverage	Expanded health coverage, particularly through higher levels of publicly funded health spending, results in lower child and adult mortality, with the beneficial effect on child mortality being larger in poorer countries.
Self & Grabowski (2003)	• 191 countries • Period: 2000 • Cross-sectional	Disability-adjusted life expectancy	• Health spending per capita (public, private) • Years of education, income, dependency ratio; calorie intake, share of urban population, pre-existing health conditions	Socioeconomic status and pre-existing health conditions play a major role. High calorie diets, high urbanisation and dependency ratio have a negative impact. Public and private health spending have an insignificant effect on DALEs in most specifications.
Torras (2005)	• 180 countries • Cross-sectional	Disability ratio, child mortality and index of health achievement	• Public health spending (% of GDP) • Income per capita and distribution; Literacy, education, political rights, women in government, internet access; water and sanitation	Some dimensions of power inequality outperform per-capita income as possible determinants of population health. The study casts doubt on the importance of per capita income in explaining environmental and health outcomes.
Yavari & Mehrnoosh (2006)	• 89 countries • Period: 1984-6 • Cross-sectional	Life expectancy at birth	• Health expenditure; doctor density • GNP per capita; adult literacy rate; daily calorie supply of food	There is a positive strong correlation between life expectancy and per capita income, health expenditures, literacy rate and daily calorie intake. There is also a negative strong correlation between life expectancy and the number of people per doctor.

ANNEX 2 – RESULTS OF NEW HEALTH PRODUCTION FUNCTION ANALYSIS

Methods and Data

102. This analysis examines the determinants of health, assessing the relative contribution of different factors within and beyond the health system. To do so, the study develops an empirical *health production function* by using macro-level panel data. It extends previous OECD work of Joumard and colleagues (OECD 2010a) by expanding the time period and countries covered, analysing new variables, and refining the econometric methodology. Life expectancy (LE) at birth for the total population is used as the health outcome measure. Explanatory variables reflect health spending and access to care; income and other socioeconomic factors; lifestyle; and the environment (detailed further below).

The main analysis covers 35 OECD countries for the period 1990-2015.

The health production function takes the following general form:

$$LE_{i,t} = \alpha_i + \beta_1 W_{i,t} + \beta_2 X_{i,t} + \beta_3 Y_{i,t} + \beta_4 Z_{i,t} + e_{i,t} \quad \text{[Equation 1]}$$

where $LE_{,t}$ is the life expectancy at birth for country *i* in year *t*; α the country effect; and *e* is the error term. W is a vector of health system variables (*health care spending*, measured by total health expenditure expressed in per capita constant US$ 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 (prevalence of daily *smokers*, *alcohol* consumption in litres per capita, prevalence share of the population having of a daily *vegetable* consumption). Y is a vector of income and other socioeconomic variables (*income* measured by GDP per capita at constant US$ 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 (*air pollution* measured by the share of the population exposed to fine particulates PM2.5). Chosen variables reflect key determinants of health, and are consistent with variables included in previous empirical health production function analyses.

103. The general econometric specification was a GLS model with country fixed effects (specified by country dummies), country-specific autocorrelation structure for errors (AR(1)) and correction for heteroscedasticity. All variables are expressed in logarithmic form.

104. A standard empirical model of the health production function (Equation 1) was used as a starting point, including all explanatory variables. This was complemented by empirical models with further specifications for possible endogeneity issue and time-effects. That is, three different empirical models were run:

- Model 1: a standard model, including all explanatory variables.
- Model 2: as per model 1 but with 5-year lagged variables to correct for possible endogeneity.
- Model 3: as per model 2 but adding a linear time trend variable to control for time-specific unobserved factors.

105. Using lagged variables in Model 2 corrects for possible endogeneity, which may arise because of simultaneity between life expectancy and some of the explanatory variables expressed in Equation 1.Also it takes into account possible delayed long-term effects of the key determinants of health.

106. Adding the time trend variable in Model 3 accounts for time-specific effects on life expectancy that are not captured by explanatory variables. That is, it assumes that unobserved factors contribute to changes in life expectancy at given moments in time – examples could be technological progress in life-saving interventions or changing patterns of disease. Results from a linear time trend variable are reported here. This assumes a linear evolution over time, for example continuous technical progress. A slightly different specification using year-specific time dummies was also tested, assuming shocks at specific points in time, producing very similar results.

107. An extended analysis included additional 8 non-OECD countries (Brazil, China, Colombia, Costa Rica, India, Indonesia, Lithuania, and Russian Federation). In this extended analysis, countries were grouped into high-income (HIC) and low- and middle-income countries (LMIC) to allow for differential affects across income levels. This was done by including an interaction term between each explanatory variable and a dummy variable for LMICs. This analysis 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.

108. Data came from the OECD Statistics database, complemented with indicators from the World Bank. Table A2 presents the broad set of variables and main data gaps. To minimize data gaps, we used a standard linear interpolation with linear extrapolation outside of the known data range. All analyses were performed using Stata 14.

Table A2. Definition and data sources

Key dimensions	Variables	Source
Life expectancy	o Life expectancy at birth	OECD Health Statistics database
Health spending	o Total Health Expenditure (THE) expressed in $PPP per capita	OECD Health Statistics database
	o Out-of-pocket payment (OOP) as a measure of access to health care	OECD Health Statistics database
Lifestyles	o Alcohol consumption in litre per capita per year	OECD Health Statistics database
	o Rate of daily smokers among adults	OECD Health Statistics database
	o Rate of people who consume vegetable daily	OECD Health Statistics database
	o Rate of adult obesity (self-reported)	OECD Health Statistics database
Socioeconomic factors	o GDP net of total health expenditure, expressed in $PPP per capita	OECD Health Statistics database
	o Rate of people who attained above primary school	World Bank database
	o Long-term unemployment rate	World Bank database
Environment	o Share of population exposed to fine particulates (PM2.5)	World Bank database

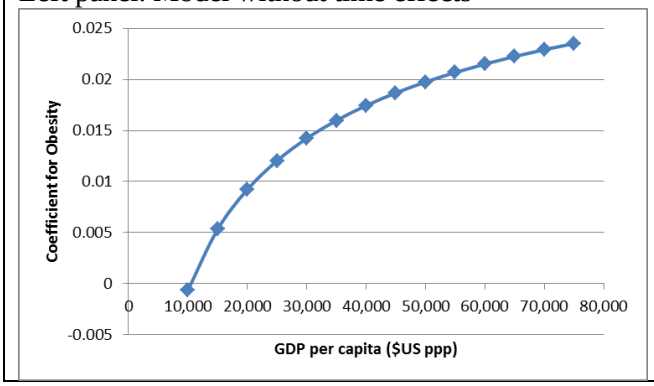
109. The econometric methods employed resolved a number of limitations by addressing endogeneity issues, considering heteroscedasticity and autocorrelation in the error structure of panel data, and performing different set of analyses according to country data availability as well as sensitivity analyses. As a further check, additional regressions excluding the United States were performed (since it is an outlier in terms of health spending) – results remained stable. However, it is important to reiterate that observed associations between socioeconomic factors and health does not guarantee causality.

Further exploration of the impacts of obesity, unemployment and air pollution on life expectancy

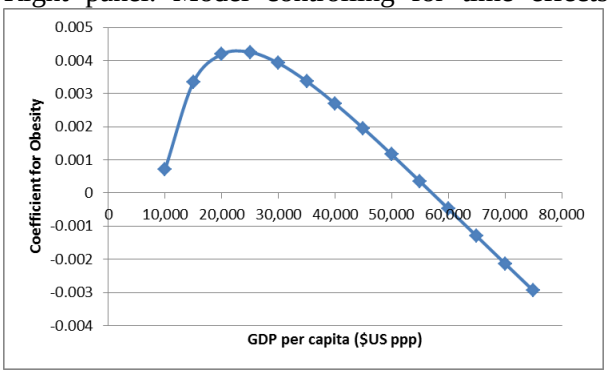
110. As shown earlier, results show a counterintuitive, positive association between the obesity rate in a country and life expectancy at birth. Explorative analysis allowed testing this association at different levels of national income, by incorporating a non-linear interaction term between obesity and GDP. It revealed that the association between obesity and life expectancy changes at different levels of GDP (Figure A1). When the model does not control for time trend (left panel) the association between obesity and life expectancy remains positive at all levels of GDP. When the model accounts for a time trends, the strength and the direction of the association between obesity and life expectancy change at a certain level of GDP per capita (right panel). From levels of GDP above $57,000 per capita, the effect of obesity on life expectancy becomes negative. Also, the strength of the association between obesity and life expectancy increases with the level of income up to levels of GDP around $23,000 per capita, where it starts to decrease. These results suggest that while obesity consistently increases with national income; after a certain level of income, the adverse health effects of obesity outweigh the positive health effects of economic growth.

Figure A1. Association between obesity and life expectancy changes at various levels of GDP per capita

Left panel. Model without time effects



Right panel. Model controlling for time effects



Note: Multivariate regression models are similar to Model 2 and Model 3 (presented in Table 2), adding a non-linear interaction term between obesity rate and GDP per capita.

111. Similarly, results show a counterintuitive, positive association between unemployment rate and life expectancy at birth. A further analysis – which introduced interaction terms between unemployment and country fixed-effect – showed that this effect is driven by a number of countries, revealing high variability across countries. Indeed, it had a significant negative (significant) coefficient in 4 countries (Belgium, France, Netherlands and the United Kingdom) and a positive coefficient in 8 countries (Finland, Germany, Iceland, Israel, Japan, Latvia, Luxembourg and Sweden). Further, using a random-effects model where unemployment is modelled as a random coefficient, its overall effect becomes statistically insignificant. This finding can be justified since evidence in the literature suggests that unemployment rate can have both positive or negative effects on life expectancy (through reduced traffic accident and lower pollution, but poorer mental health) (van Gool and Pearson, 2014); potentially reflecting a high heterogeneity in the unemployment effect across countries.

112. The association between air pollution and life expectancy is not significant; this is partly explained by the fact that variations in air pollution over time (1990-2010) are very small in 14 out of 35 OECD countries. The share of population exposed to high level of PM2.5 remains virtually unchanged for the whole studied period in 14 countries (where it is equal to 0% in Iceland, and nearly 100% in 12 other countries).

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