Factors Explaining Life Expectancy at Age 65: A Panel Data Approach Applied to European Union Countries.

Abstract

The aim of this paper is to explain the determinants of longevity in 20 European Union (EU) countries for which comparable data are available for the period 1990-2016. We use a health equation to explain life expectancy at age 65 for total population considering socioeconomic factors, population structure, health resources, lifestyles and environment as the main determinants of health status. Panel estimation techniques are implemented to estimate the health equation with lagged explanatory variables to attenuate the endogeneity problems of regressors. Our evidence shows that *per capita* income, education and pharmaceutical expenditures positively affect life expectancy at the age of 65. As expected, risky lifestyles and air pollution have a significant negative impact on health. The interaction between population age structure and pharmaceutical expenditures proves also to be important for explaining longevity. Our evidence reinforces the idea that investing in education and health care provision is the way to achieve healthier longevity allowing a more active participation of the elderly in society.

Keywords: Life expectancy at age 65, socioeconomic status, panel data.

JEL code: C23, Q53, I14, I15

1. Introduction

Health achievements in the most developed countries are well illustrated by the gain of about 30 years in life expectancy which has been considered one of the most important attainments of the 20th century (Christensen *et al*., 2009). In these countries, increasing longevity along with a decreasing trend on birth rates explain the deepening of an ageing population process that raises financial challenges on social security systems. As a consequence of a higher life expectancy many countries have adjusted their retirement systems so people have to work beyond 65 years old. This is in line with an active population strategy, assuming a different perspective on elderly people having a dynamic role in society – such as in labour markets or volunteerism – rather than being considered a burden on society (Zaidi, 2014).

The European Union (EU)'s awareness towards the ageing of the developed world and the need to promote research and investment to overcome the main healthcare challenges is rather clear through the EU's Horizon 2020 specific topic on "health, demographic change and wellbeing", designed under an even broader framework, reflecting the EU's commitment at the international level to meet the 2030 Agenda for Sustainable Development. More specifically, one of the threats has to do with the potential escalation of health and care costs related to the increasing prevalence of chronic diseases that is urgent to fight by providing smart and sustainable solutions. In addition, it is also clearly expressed the need to overcome the influence of external environmental factors on health such as the climate change or air quality.

In fact, demographic transition implies a more inclusive perspective of older people and the adoption of policies and programs that minimize financial and social risks. According to Zaidi and Howse (2017), some of the specific policy areas that should be incorporated in active ageing strategies are: fostering employment, promoting engagement, reducing poverty, improving health and wellbeing, and lifelong learning. In this context, it is worth mentioning a joint project between the United Nations Economic Commission for Europe and the European Commission's Directorate General for Employment, Social Affairs and Inclusion, that has the mission of monitoring policy implementation in the 28 EU Member States to promote longer working life, social involvement, healthy lifestyles and opportunities for independent living (Zaidi *et al.*, 2013). This involves the construction of an Active Ageing Index based on four domains: employment, social participation, independent living, and capacity for active ageing. All the indicators are measured separately for men and women, highlighting gender gaps in active ageing and identifying challenges and policy priorities linked with population ageing.

In a similar approach, Chen *et al.* (2018) developed a multidimensional Aging Society Index using the Organization for Economic Cooperation and Development (OECD) and World Health Organization (WHO) data to assess how 18 OECD countries are adapting their economies to ageing, considering five dimensions: productivity and engagement, wellbeing, equity, economic and physical security, and intergenerational cohesion. Their results show that there is a substantial diversity across countries: for any given domain there are wide differences across countries, and within most countries, there is substantial variation across domains.

In this context, we refer Zaidi *et al.* (2013) and Chen *et al.* (2018) as two examples of studies that aim to monitoring how countries are adapting their economies to ageing and compare their performances. In this perspective, the methodologies used by Zaidi *et al.* (2013) and Chen *et al.* (2018) are very different from ours, since their main aim is not to investigate the determinants of longevity as we do, but instead to assess if countries are adopting adequate strategies to ageing society's challenges. The methodology of these two studies develops a multidimensional score/index based on different domains attributing specific weights.

There are still important divergences across countries and within most countries. As a consequence, although the inclusion and participation of the elderly is generally positive for ageing wellbeing, it should be noticed that ageing strategies associated with the delay of the retirement age may represent a double cost for the most disfavoured socioeconomic groups. In a recent report by OCDE (2016) it is noticed that wealthier socioeconomic groups live longer than those belonging to less-wealthier groups and these differences may be increasing over time. In this context, and according to the same study, individuals in low-income socioeconomic groups may be penalized by the adoption of policies that encourage people to work longer following the average increases in life expectancy since they will be working longer but not necessarily living longer.

An important source for these inequalities lays in education with highly educated people likely to live longer. In fact, education, being directly linked with health literacy, is seen as one driving force of health spending efficiency since higher levels of education contribute to the development of cognitive and psychosocial competencies that play a critical role in explaining individuals' lifestyle choices. In this context, at a macroeconomic level, the existence of health inequalities in European Union (EU) countries based on socioeconomic status has negative impacts on health, social cohesion and economic development (Corsini, 2010).

Having all these in mind, our aim in this paper is to analyse the main determinants of the health status of the population characterized by their longevity (proxied by life expectancy at 65 years old). For this purpose, we use a panel data approach to disentangle and to better measure the effects of factors like income, education, lifestyles, health resources and environment on life expectancy at 65 years' old. Three main aspects can justify the contribution of this paper to the literature: (i) a health equation is estimated using socioeconomic, demographic, lifestyle, health care provision and environment quality factors to explain longevity in 20 EU countries. In this way we try to perform a more ambitious overarching analysis seeking to achieve higher explanatory power; (ii) there is few research in the literature measuring the impact of environmental factors for explaining life expectancy at late age; (iii) the use of interaction terms, calling the attention for the existence of both direct and indirect effects of a variable over life expectancy.

The paper is organized as follows. Besides the introduction, section 2 explains the determinants of health status at late age, and reviews the existing literature. In section 3 we explain the model, the data and the methodology used in the empirical analysis. The results obtained from the estimation approach are presented and discussed in section 4. The last section summarizes the main findings suggesting some policy implications.

2. The Determinants of Health Status at Late Age: A Literature Review

Increasing longevity in developed countries is the result of a sustainable decrease trend on mortality rates in late ages since the second half of the 20^{th} century. Raising living standards, education, better access to healthcare and medical technology advances, lifestyle changes and environmental improvements are found to be important to explain differences in life expectancy across countries (Rau *et al.*, 2008; Beard *et al.*, 2016; OECD, 2017b).

However, living longer does not necessarily mean living better. In fact, when we consider the health status of the elderly group we should also take into account some factors that may turn this status more vulnerable. First, as people get older and live longer it is more likely the prevalence of certain diseases (particularly chronic diseases). This phenomenon - known as the effect of general biological deterioration – is reflected by the significant increase of the incidence of various diseases after the age of 65 and by the general deterioration of physical robustness during old age (Kiuila and Mieszkowski, 2007). Moreover, ageing is also associated with an increased risk of a person having more than one disorder at the same time (multimorbidity), affecting physical and mental (including psychosocial) capacities and the quality of life (Beard *et al.,* 2016). From this perspective, demographic ageing is affected by mortality selection at younger ages but also by mortality selection at late ages (Kiuila and Mieszkowski, 2007; Zheng, 2014). Another important issue is the poverty risk that grows with age (OCDE, 2016) and can be also related to widowhood and the exit from the labour market (retirement), two events with significant psychosocial and financial impacts on health, resulting in income changes and increased risk poverty (OCDE, 2016).

Having in mind the extremely complex process of ageing, it is challenging to use several health proxies to capture the multidimensionality of health status. Most studies on the determinants of longevity use more conventional health proxies such as mortality rates or life expectancy at birth or at age 65. Using life expectancy as a proxy for health outcomes has the advantage of the greater availability and higher data quality. However, it focuses specially on quantitative rather than on qualitative aspects, and therefore may underestimate health outcomes in developed countries related to the improvement of the quality of life. Other important and interesting measures of health outcomes would be the use of indicators to express more qualitative aspects of the health care system, such as healthy life years, morbidity or premature death indicators. However, the use of some of these indicators (such as healthy life years or self-perceived health status) is conditioned by the availability and subjectivity of data since they are based in self-declared individuals' evaluation (Eurostat, 2018). As a proxy for these qualitative aspects, some authors, like Or (2000), use a premature mortality indicator- "potential years of life lost" – that is available for OECD countries. Nevertheless, this indicator does not consider survival after 70 years old, which strongly restrains its application since a large amount of health resources in developed countries are concentrated at the elderly population (Joumard *et al.*, 2008). Therefore, life expectancy remains one of the most frequently used indicators of health status (Eurostat, 2018).

Most empirical studies that examine the determinants of health status at an aggregate level usually follow the health production function approach which considers socioeconomic, healthcare resources and lifestyle as the main determinants of health status (usually proxied by life expectancy)[1]. It is consensual in the literature that life expectancy (at age 65 or at other ages) is influenced by several dimensions: socioeconomic status, health care, behavioural patterns and environmental exposure (Schroeder, 2007).

2.1. Socioeconomic and demographic factors

As it is known, higher income is associated with better health. It entitles individuals to better quality of life, which can be related to healthier nutrition, higher investment in education and greater access to health care products and services with positive consequences on health (Joumard *et al.*, 2008; Poças and Soukiazis, 2010). In turn, a higher level of education in developed countries is associated with better jobs and better wages which allow for better health care provision. Skilled workers usually have safer jobs (as they do more intellectual than physical work) and enjoy better working conditions. On the other hand, more educated people are more informed and aware of the risks of adopting less healthy lifestyles. They also use health care resources more efficiently, being more likely to adopt a health-seeking behaviour.

[1] See, for instance, Or et al. (2005), Shaw et al. (2005), Ramesh and Mirmirani (2007), Ricci and Zachariadis (2009) and Joumard et al. (2008), Fayissa and Traian (2011), among others.

The impact of education and income on health is well documented in the literature. In a recent study, Chetty *et al*. (2016) using USA data on earnings and mortality records for the period 2001-2014, found that regardless of gender, the richest live longer than the poorest. As the authors of the study point out, the association between income and life expectancy is not necessarily direct; it may be driven by other factors correlated with both health and income, such as differences in education or health behaviours. In fact, income, occupational status, education and living conditions have direct and indirect effects on health inequalities (James *et al*., 2017).

Using data for the OECD countries in 2011, Murtin *et al*. (2017) show evidence that, on average, the gap in life expectancy between highly educated and poorly educated people at age 65 is about three years. The same evidence is referred by James *et al*. (2017) noticing that people with tertiary level education live around six years longer than those with the lowest level of education.

From a different perspective, Mackenbach *et al*. (2010) estimate the economic costs of health inequalities in the EU to be around 1.4% of the GDP at an annual base. According to the authors' estimation, if health of those who have lower secondary education improves to the average level of health of those with at least higher secondary education, it would be possible to save health losses that account for 20% of the total costs with healthcare and 15% of the total costs with social security benefits.

Using data from seven annual waves (1995-2001) of the European Community Household Panel – with health measured in terms of disability in daily activities and socioeconomic status based on education level –, Majer *et al*. (2011) show evidence that higher educated people live longer in good health before retirement and can expect to live longer afterwards. The same evidence is referred by OCDE (2016), noticing that in most OECD countries the longevity gap between high and low-educated people has remained constant or has slightly increased over the last decade.

2.2. Health care

It is well established in the literature that improvements in health care services will be reflected in a better health status[2]. Nevertheless, it is also consensual that in most developed countries additional gains will be harder to obtain, since these countries have already reached a high average level of life expectancy and now they must deal with the challenges of sustaining an ageing population and the burden of an increasing prevalence of chronic diseases. Or *et al.* (2005) show that for 21 OECD countries, for the 1970-1998 period and using panel data regressions, the impact of health care (measured by the number of doctors) on life expectancy at birth and at age 65 varies significantly across countries. They notice that the availability of advanced medical technology also plays an important role. Using the health production function for developed countries, Shaw *et al*. (2005) found pharmaceutical expenditures to have a positive effect on life expectancy at middle and late ages.

With ageing it is expectable that the demand for healthcare services increases as a consequence of the natural biological deterioration process, increasing the prevalence of chronic diseases and mental disturbances (an important cause of morbidity of the elderly). Beard *et al.* (2016) corroborate this idea noticing that multimorbidity is also associated with increased rates of health care use and increased costs.

In spite of the expectable increase regarding healthcare needs, demand for healthcare may be conditioned by income status. The greater prevalence of poverty (defined as having less than 60% of the national median income) among people older than 65 years prevents many of them from affording the cost of health services and medical prescriptions, also depending on national health security systems (WHO, 2017a).

2.3. Behavioural patterns

The health status of the elderly is related to behavioural choices made along life, regarding diet, exercise, smoking and alcohol consumption. In fact, the negative consequences of risky behaviours on individuals' health are generally observed only some years later.

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[2] It must be noticed that more resources do not reflect necessarily better health outcomes since they depend also on the efficiency of the use of health care resources.

Nevertheless, it is important to have in mind that, according to WHO (2017a), changing behaviours is beneficial at any age: for instance, stop smoking at age 60–75 decreases the risk of premature death by 50%. However, there are some reasons that make giving-up smoking more difficult among older smokers, such as longer duration of the smoking habit, higher number of cigarettes smoked daily or lower motivation (Lugo *et al*., 2013).

Tobacco smoking has been estimated by the WHO to kill 7 million people each year (WHO, 2017b). Smoking habits have been identified as the major cause of preventable death in the OECD countries. Health problems related to smoking depend on the duration (years of smoking) and the intensity of use (number of cigarettes smoked). The main causes of death associated with smoking are cardiovascular diseases, chronic pulmonary diseases and lung cancer. OECD (2017) notices that, although smoking rates have decreased in most OECD countries, 18% of adults still smoke daily, with European countries like Greece, Hungary and Turkey reporting the highest rates. Another important fact is that smoking is more concentrated among people with a lower level of education: about 20% of adults with a lower level of education smoke daily compared to 14% of those with a higher level of education on average across EU countries (OECD, 2016).

In a recent paper, Nash *et al.* (2017) study a large cohort in USA (with participants over 70 years old) to investigate the associations of mortality at late age and smoking habits. In this study participants were asked to answer a questionnaire detailing their smoking habits in 2004-2005 (self-reported age at smoking cessation, age at smoking initiation and amount smoked after age 70) and were followed for mortality through 31st December of 2011. The results of this study show evidence that mortality is inversely associated with smoking initiation age and directly associated with the number of cigarettes smoked per day after 70 years old.

In what concerns alcohol consumption, excessive consumption is considerable in most parts of the world and it is responsible for high levels of morbidity and mortality. It is associated with the risk increase of heart stroke and vascular diseases, liver cirrhosis and certain cancers. Foetal exposure to alcohol also raises the risk of birth defects and intellectual capacity. Excessive alcohol consumption is also often associated with death and disability caused by accidents and injuries, and with assault, violence, homicide and suicide

(OECD, 2017). In spite of the well-known harmful effects of excessive drinking on health, in 13 OECD countries alcohol consumption has increased since 2000, such as in Belgium, Iceland, Latvia and Poland (OECD, 2017) and it is estimated to have caused 3.3 million deaths worldwide every year, representing 5.9 % of all deaths (WHO, 2018). Nevertheless, like tobacco, it is one of the major avoidable risk factors for disease.

According to the National Institute on Alcohol Abuse and Alcoholism (2008), older adults are more likely to have alcohol-related problems since their health conditions can be severely deteriorated by alcohol consumption. Some of these problems include stroke, hypertension, neurodegeneration, cognitive or emotional problems, among others. At the same time, elderly individuals usually take medication and so they are at risk for interactions that can be dangerous for their health. On the other hand, alcohol may decrease effectiveness of some medications.

2.4. Environmental exposure

Population exposure to air pollution is also a critical determinant of health. It is related to lung cancer, respiratory and cardiovascular disease, low birth weight, dementia and other health problems, with elderly people particularly susceptible to these adverse effects (OECD, 2016; OECD, 2017). [3] There is empirical evidence that fine particles are dangerous for the health status, with exposure linked to decreased life expectancy, and it is a matter of public health concern (Qian Di *et al.*, 2017; European Environment Agency, 2018).

Monsef and Mehrjardi's (2015) study is one of the few examples that investigates the effects of CO2 emissions, among others, on life expectancy at birth using panel data and fixed effects techniques for 136 countries over the period 2002-2010. Although the study does not consider, for instance, relevant variables such as those related to habits and

[3] CO2 emissions can be understood as a proxy for climate change, due to their close link, as discussed in IPCC (2018), in the context of consolidating a response at the global level, in order to react to the threat of climate change and promote sustainable development and poverty eradication. Cumulative CO2 emissions are responsible for global warming, independently from where they occur. Thus, to restrict climate change it is essential to reduce greenhouse gas emissions continuously (Knutti, 2013).

lifestyle, it is relatively innovative in the sense that calls the attention for the importance of environmental issues and their relation with health.

In a recent study, Cakmak *et al.* (2018) follow for 20 years a population based cohort (1991-2011), with participants being 25 years old or over at baseline and usual residents of Canada, to investigate the associations between long term PM2.5 and ozone exposure and mortality. Their results show that, in seven climate identified geographic zones in Canada, exposure to particles of air pollution (*PM2.5)*[4] was related to an increased risk of mortality from lung cancer, and both ozone and *PM2.5* exposure were related to risk of mortality from ischemic heart disease, with the risk varying spatially by climate zone. Turner *et al*. (2016) and Crouse *et al*. (2015) study large cohorts (in USA[5] and Canada[6], respectively) to analyse the relationship between long-term exposures to *PM2.5* and ozone and mortality and find that there are positive associations between several common causes of death and environmental exposure. However, according to Qian Di *et al.* (2017), these studies with large cohorts usually include people with socioeconomic status higher than the national average and who live in urban areas, thus lacking statistical power to estimate the health effects in underrepresented groups. Using an open cohort of all 65 years old Medicare beneficiaries in the United States from the years 2000-2012, the authors find significant adverse effects on health from exposure to *PM2.5* and ozone even at concentrations below current national standards, more pronounced among minorities and people with low income. This finding is in line with Deguen and Zmirou-Navier's (2010) study that reviews some of the literature on the mechanisms through which environmental exposure may contribute to social health inequalities in Europe, namely differential exposure and differential susceptibility. As the authors notice, there is a general pattern with most disfavoured populations, although not always more exposed, suffering greater negative health consequences of air pollution since they are more vulnerable.

[4] PM (particle pollution) is the term used to define a mixture of solid particles and liquid droplets found in the air exposures to fine particulate matter (inhalable particles measuring <2.5 μm in aerodynamic diameter [PM2.5]).

[5] Participants were followed for 22 years and were 30 years old or over at baseline (1982).

[6] Participants were followed for 16 years and were 25 years old or over at baseline (1991) and usual residents of Canada.

In a more recent study, though from a different perspective, James *et al*. (2017), use a health production function with data from 35 OECD countries and for the period 1990-2015, showing that air pollution is not significantly associated with life expectancy gains, which can reflect, according to the authors, the long lag in time before air pollution affects individual's health and the relatively small decreases in air pollution over time in many OECD countries.

It is also important to mention the most recent report from Air Quality in Europe (European Environment Agency, 2018), where it is shown that in the EU-28, for the year 2015, the premature deaths attributed to particulate matter (PM2.5), nitrogen dioxide (NO2) and ozone (O3) exposure are 391000, 76000, and 16400, respectively. According to the same report, for PM2.5, the highest impacts on premature deaths are found in Germany, Italy, Poland, France and the United Kingdom, the countries with the largest populations.

3. Model, methodology and data description

Our study focuses on 20 European Union (EU) countries, covering the 1990-2016 period, independently from the accession date.[7] We use a panel data framework to estimate the health equation, Equation (1) that can be specified as follows:

$$le65_{i,t} = \beta_0 + \beta_1 \ln(gdppc)_{i,t-1} + \beta_2 educ_{i,t-1} + \beta_3 pop65_{i,t-1} + \beta_4 dailysmoker_{i,t-1} + \beta_5 alcohol_{i,t-1} + \\ + \beta_6 \ln(pharspend)_{i,t-1} + \beta_7 genpract_{i,t-1} + \beta_8 CO2_{i,t-1} + \beta_9 d2008 + u_i + \varepsilon_{i,t}$$

Equation (1)

The subscript *i* indicates the country and *t* the respective year observed in the sample, u_i denotes the country-specific effects capturing differences among countries which can be random or fixed, and $\varepsilon_{i,t}$ refers to the idiosyncratic error term. The error terms are assumed to have the classical "white noise" properties, that is, they are identically and independently distributed with zero mean and constant variance.

[7] Although the UK is currently under the Brexit process for leaving the European Union (EU), we still include it in our sample for being an historical EU-member. The list of the 20 EU countries is given in Table A1 in the Appendix.

The dependent variable, $le65_{i,t,}$ represents the health status proxy considering life expectancy at age 65 for total population. The explanatory variables may be grouped into three "traditional" blocs: socioeconomic and demographic factors; lifestyle indicators and supply sources of health care. To these we add a fourth factor reflecting environmental conditions.

In particular, *per capita* income (the log of *per capita* Gross Domestic Product at Purchasing Power Parity terms, *ln(gdppc)*)[8] is used to express the development level of the countries included in the sample. In addition, the proportion of population with secondary school aged 25-64 (*educ*) is included to capture literacy-related aspects. Demography is captured by the age structure of the population, namely through the proportion of people aged 65 or over (*pop65*) [9]. Two main factors are used to express lifestyle: the proportion of population of age 15 and over who smokes regularly (*dailysmoker*), and alcohol consumption of population aged 15 and over, measured in litters *per capita* - *alcohol*) [10]. Resource factors characterizing the health care system are represented by pharmaceutical expenditures *per capita* in PPP terms for consistent comparison, *ln(pharspend)* [11], and by the density of generalist medical practitioners (*genpract*), as in Gilligan and Skrepnek (2015). Finally, the impact of environmental conditions on health is captured by *CO2* emissions [12] (tones *per capita*) in an attempt to verify whether atmospheric pollution is relevant for the European population's health at a late age.

We also add a dummy variable for 2008 (*d2008*), to capture the impact of the financial and economic crisis on health of these European countries. All explanatory variables are lagged

8 The log is used for this variable for the sake of data scale normalization.

9 According to Shaw *et al.* (2005), ignoring the correlation between pharmaceutical consumption and a country's age distribution creates an omitted variable bias in the elasticity of pharmaceutical consumption, thus undervaluing the marginal effect of drug consumption on health. That bias calls the attention for the relevance of the age structure in the design of public macroeconomic policies.

10 OECD (2016) defines alcohol consumption as annual consumption of pure alcohol in litters, per person, aged 15 years and over. However, it is important to mention that the methodology to convert alcoholic drinks to pure alcohol may differ across countries: typically, beer is weighted as 4-5%, wine as 11-16% and spirit drinks as 40% of pure alcohol equivalent.

11 The log transformation is used as in per capita income. We also used *per capita* consultations as a proxy for health system's supply, but no reasonable results were found.

12 For the explanation of the variables, their description and corresponding data sources see Table A2 in the Appendix.

one period to avoid endogeneity problems due to their eventual contemporaneous correlation with the error term.

Based on the links that characterize the relation between health, income and education, we expect that both *per capita* income and education are positively related to life expectancy. Wealthier persons have the resources to live in better conditions and benefit from better health care. On the other hand, more educated people understand better the importance of living healthier and taking precautions that prolong their life quality.

The proportion of people aged 65 is a scale variable whose impact on life expectancy at 65 is ambiguous depending on factors such as income, education or health care resources. It is reasonable to expect that older people with higher income and education, as well as, with better health provision will live longer. However, the sign of the impact and the significance is a matter of empirical confirmation.

Furthermore, we expect a negative impact of risky lifestyles (smoking and alcohol consumption) on life expectancy, as they represent well known harmful habits for health. Smoking has been identified as the major cause of preventable death in OECD countries.

With what concerns health resources *proxied* in our model by pharmaceutical expenditures *per capita* and the density of generalist practitioners, we can expect that the use of medicines and treatments will be reflected in a better health status. In fact, having better health will imply higher health expenditures prolonging the elderly's life as a result of a more effective treatment. Additionally, a higher density of generalist medical practitioners will benefit the older population, thus prolonging their live expectancy.

As for environmental conditions measured by *CO2* emissions we expect them to negatively affect life expectancy records, since atmospheric pollution is harmful to health. We intend to bring more evidence on this issue since the literature has not explored sufficiently this subject.

Table 1 explains the set of variables used in the empirical approach providing some elementary descriptive statistics. It is shown that the mean value of life expectancy at age

65 (*le65*) is about 19 years, with the lowest record (15.5) in Slovenia in 1993, the Czech Republic, Poland and the Slovak Republic in 1998, Estonia in 2001, and Hungary in 2005. The maximum value (21.7) is observed in France, in 2011.

As regards *per capita* GDP (*gdppc*), the minimum level (15925.16) is observed in Estonia in 2001 and the maximum (91367.46) in Luxembourg in 2007. It is also Estonia in 2001 that displays the lowest level for *per capita* pharmaceutical expenditure (*pharspend*) - 122.9, whereas the highest is observed in Greece in 2007 (980). The proportion of population with secondary school aged 25-64 (*educ*) is the lowest in Portugal in 2007 (27.3%) and the highest in Czech Republic in 2014 and 2015 (93.2%). With respect to age structure of the population (*pop65*), the minimum proportion is registered in Ireland in 2016 (13.2%) and the maximum in Italy in 2015 (21.8%).

As for the proxies for lifestyle, Sweden in 2013 reports the lowest value for *dailysmoker* (10.7%), whereas the inverse occurs in the Netherlands in 2000 (32%). For *per capita* alcohol consumption (*alcohol*), again Sweden registers the most favorable results, with the lowest value in 2001, 2004 and 2005 (6.5 liters *per capita*), whereas Estonia in 2007 possessed the highest level (14.8 liters *per capita*).

The statistics for the density of generalist practitioners (*genpract*) show that Greece in 2007 had the lowest value (0.32 *per* 1000 inhabitants), whereas Portugal in 2015 had the highest record (2.41 *per* 1000 inhabitants).

Finally, with respect to environmental pollution given by the *CO2* emissions *per capita*, the lowest air pollution was registered in Sweden in 2015 (5.5 tons per capita), while the most disadvantageous result was observed in Luxembourg in 2005 (27.9 tons per capita).

Table 1- Descriptive Statistics, 20 European Union Countries- 1990-2016

Variable		Mean	Std. Dev.	Min	Max	Obs
	Overall	18.869	1.303	15.500	21.700	N*T=150
	Between		1.258	16.500	20.775	N=20
le65	Within		0.842	16.385	20.803	Average T=7.5
	Overall	40914.48	15717.94	15925.160	91367.460	N*T =149
gdppc	Between		14818.55	20051.480	84794.750	N=20

	Within		2377.931	32439.100	47487.19	Average T =7.5
	Overall	75.323	11.181	27.300	93.200	N*T =150
	Between		14.071	36.200	91.756	N=20
educ	Within		4.774	54.586	86.157	Average T =7.5
	Overall	16.451	1.861	13.200	21.800	N*T =150
	Between		1.838	13.200	21.150	N=20
pop65	Within		1.055	13.523	19.487	Average T =7.5
	Overall	21.440	4.880	10.700	32.000	N*T = 108
	Between		3.711	14.407	27.222	N = 10
dailysmoker	Within		3.130	12.804	29.902	Average T = 10.8
	Overall	10.698	2.040	6.500	14.800	N*T = 140
	Between		1.713	7.000	13.633	N = 18
alcohol	Within		0.785	8.035	13.635	T = 7.778
	Overall	377.806	120.729	122.900	980.000	N*T = 146
	Between		166.613	248.075	980.000	N = 19
pharmspend	Within		71.2512	221.632	590.706	Average T = 7.7
	Overall	0.980	0.391	0.320	2.410	N*T = 145
	Between		0.505	0.320	2.095	N = 20
genpract	Within		0.079	0.665	1.295	Average T = 7.3
	Overall	12.111	4.695	5.500	27.900	N*T = 145
	Between		4.110	5.800	23.786	N = 19
CO2	Within		1.445	6.325	16.225	T = 7.6

Source: Authors' own calculations.

The following correlation matrix shows the inexistence of multicollinearity among the explanatory variables with values rarely exceeding 0.5 (only in one case). The first column indicates the correlation between the dependent variable and explanatory factors revealing a significant association in the majority of cases.

Table 2. Correlation matrix, 20 European Union countries, 1990-2016

	$le65_{i,t}$	$ln(gdppc)_{i,t-1}$	$educ_{i,t-1}$	$pop65_{i,t-1}$	$dailysmoker_{i,t-1}$	$alcohol_{i,t-1}$	$ln(pharspend)_{i,t-1}$	$genpract_{i,t-1}$	$co2_{i,t-1}$
$le65_{i,t}$	1.000								
$ln(gdppc)_{i,t-1}$	0.340	1.000							
	(0.000)								
$educ_{i,t-1}$	-0.196	-0.120	1.000						
	(0.016)	(0.144)							
$pop65_{i,t-1}$	0.411	-0.371	0.066	1.000					
	(0.000)	(0.000)	(0.421)						
$dailysmoker_{i,t-1}$	-0.600	-0.313	-0.281	-0.375	1.000				
	(0.000)	(0.000)	(0.001)	(0.000)					
$alcohol_{i,t-1}$	-0.321	-0.046	-0.138	-0.418	0.567	1.000			
	(0.000)	(0.577)	(0.092)	(0.000)	(0.000)				
$ln(pharspend)_{i,t-1}$	0.578	0.315	0.124	0.320	-0.486	-0.170	1.000		
	(0.000)	(0.000)	(0.130)	(0.000)	(0.000)	(0.037)			

$genpract_{i,t-1}$	0.326	-0.041	-0.272	0.094	0.046	0.316	-0.021	1.000	
	(0.000)	(0.621)	(0.001)	(0.251)	(0.579)	(0.000)	(0.799)		
$co2_{i,t-1}$	-0.214	0.621	0.001	-0.622	0.185	0.335	-0.025	-0.144	1.000
	(0.009)	(0.000)	(0.990)	(0.000)	(0.024)	(0.000)	(0.758)	(0.079)	

Note: Statistical significance is presented under parentheses for each pair of correlations. Authors' own calculations.

4. Empirical results and discussion

The results of estimating Equation (1) using panel data[13] for a set of 20 EU countries are reported in Table 3. Three different versions are estimated for the sake of comparison: (i) The Pooled OLS Model (column 1) where no heterogeneity is assumed among countries, the most restrictive version; (ii) the Fixed Effects Model (FE) in column (2) where differences between countries are accounted for in the individual intercept attached to each country. These differences are invariant in time, such as, country size, natural resources, institutions, traditions among others. The Least Squares Dummy Variables (LSDV) approach is used to estimate the fixed effects model using country specific dummy variables[14]; (iii) the Random Effects Model (RE) (column 3) where country differences are assumed random and captured in the error term u_i as shown in Equation (1). The Generalised Least Squares (GLS) approach is used to estimate this model known as the quasi-demeaned process. The assumption that the u_i are uncorrelated with the regressors is crucial in this approach to obtain consistent estimators[15].

In the bottom of Table 3, the Hausman test suggests that the random effects model is the most appropriate one, since the null hypothesis that the random effects estimator is consistent is not rejected at the 5% level (but not at the 10% level). However, differences between the fixed effects and random effects are not substantial, both in terms of the estimates and of the statistical significance of coefficients. This similarity on the results can

[13] Since we have cross-section and time-series data the most appropriate manner to estimate the health equation (1) is using panel data estimation techniques. In this way we have gains in information (within groups and between groups) and in estimation efficiency due to a large size sample, ensuring the asymptotic properties of the estimates.

[14] The country dummies are not reported due to space limitations

[15] For detailed information on the panel data estimation methods see Baltagi (2005).

be justified by the value of the quasi-demeaned parameter[16] θ which varies from a minimum 0.680 to a maximum 0.923. Therefore, the random effects model almost collapses to the fixed effects model, especially when we consider the maximum value of θ, close to 1. Since the Breusch-Pagan/Cook-Weisberg test points to the existence of heteroscedasticity and the Wooldridge test indicates error autocorrelation (AR1), the same versions (1) to (3) are estimated using robust standard errors; the new results are reported in columns (4) to (6), respectively.

As can be checked from Table 3, all estimated coefficients have their expected signs. Higher *per capita* income levels and education, along with higher health care provision (through medication expenditures) have a positive and significant impact on longevity. On the other hand, as expected, unhealthy lifestyles related to alcohol and tobacco consumption have significant and negative effects on health, reducing life expectancy at age 65. Atmospheric pollution (*CO2* emissions) has a negative impact on longevity, displaying statistical significance in the OLS and RE regressions only. At this stage, there is not strong evidence for the harmful impact of pollution on life expectancy.

The most efficient outcomes are those from column (6) – Random Effects with robust standard errors. Therefore, we will focus our analysis on the results from that regression, with the option being supported by statistical tests, as explained previously. In particular, it is predicted that a 10% increase in per capita income in the previous year originates a 0.2-year increase in life expectancy at age 65, with everything else constant. This is what was expected initially, given that the literature has been reporting that wealthier persons live longer as indicated by Joumard *et al.* (2008), Chetty *et al.* (2016) and James *et al.* (2017). Furthermore, the educational status also contributes positively to life expectancy of the elderly. It is shown that a 1 percentage point (p.p.) increase in educational standards of the previous year is responsible for a 0.02-year increase in live expectancy at age 65, and this impact is statistically significant at the highest 1% level. It is therefore confirmed that education plays an important role in prolonging life, since more educated people

[16] This parameter is given by $\theta = 1 - \sqrt{\frac{\sigma_\varepsilon^2}{\left(T\sigma_u^2 + \sigma_\varepsilon^2\right)}}$ with $0<\theta<1$

understand better the need for health care and take precautions towards a healthier mode of living, as suggested by Mackenbach *et al.* (2010) Majer *et al.* (2011) Murtin *et al.* (2017) and James *et al.* (2017).

Table 3. Estimation results of life expectancy at age 65: European Union countries, 1990-2016.

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	(6)
VARIABLES	OLS	FE	RE	OLS-ROB	FE-ROB	RE-ROB
$\boldsymbol{ln(gdppc)_{i,t-1}}$	1.9415***	2.3813***	2.3481***	1.9415**	2.3813**	2.3481***
	(6.570)	(2.787)	(4.335)	(2.770)	(2.367)	(3.970)
$\boldsymbol{educ_{i,t-1}}$	-0.0204***	0.0427***	0.0224***	-0.0204	0.0427***	0.0224***
	(-3.715)	(5.290)	(3.432)	(-1.350)	(7.026)	(2.715)
$\boldsymbol{pop65_{i,t-1}}$	0.1601***	0.0738*	0.0551	0.1601**	0.0738	0.0551
	(3.463)	(1.833)	(1.460)	(2.521)	(1.705)	(1.097)
$\boldsymbol{dailysmoker_{i,t-1}}$	-0.0570***	-0.0639***	-0.0477***	-0.057	-0.0639***	-0.0477***
	(-3.202)	(-4.278)	(-3.284)	(-1.656)	(-4.647)	(-3.635)
$\boldsymbol{alcohol_{i,t-1}}$	-0.0367	-0.1840***	-0.1646***	-0.0367	-0.1840***	-0.1646***
	(-0.958)	(-4.556)	(-4.563)	(-0.646)	(-4.885)	(-6.039)
$\boldsymbol{ln(pharspend)_{i,t-1}}$	1.0277***	1.0076***	1.2875***	1.0277***	1.0076***	1.2875***
	(4.908)	(3.612)	(5.595)	(3.404)	(3.158)	(4.527)
$\boldsymbol{genpract_{i,t-1}}$	0.9152***	-0.5851	0.3469	0.9152**	-0.5851**	0.3469
	(5.584)	(-1.274)	(1.113)	(2.662)	(-2.141)	(1.031)
$\boldsymbol{CO2_{i,t-1}}$	-0.0775***	-0.0247	-0.0648**	-0.0775	-0.0247	-0.0648
	(-3.983)	(-0.872)	(-2.413)	(-1.618)	(-0.617)	(-1.564)
d2008	0.0591	-0.0335	-0.0324	0.0591	-0.0335	-0.0324
	(0.244)	(-0.286)	(-0.272)	(0.431)	(-0.344)	(-0.466)
Constant	-6.9586*	-12.2341*	-12.6445***	-6.9586	-12.2341	-12.6445***
	(-1.969)	(-1.694)	(-2.730)	(-0.874)	(-1.585)	(-2.984)
Observations	150	150	150	150	150	150
N. of countries	20	20	20	20	20	20
F-test	51.21[0.00]	137[0.00]		76.69[0.0]	2440[0.00]	
χ^2			1069.68[0.00]			4374.6[0.00]
R^2	0.767	0.911	0.903	0.767	0.911	0.903
θ_min/max			0.656/0.913			0.656/0.913
BP/CW hetero. test	x_1^2=3.89[0.048]					
Wooldridge AR test	$F_{(1,8)}$ = 29.565 [0.001]					
Hausman test		x_9^2=15.66[0.074]				
BP LM test for RE			x_1^2=96.68[0.00]			

Note: ***,**, * - Coefficient significant at the 1%, 5% and 10% level, respectively. Numbers in parentheses are t-ratios. Numbers in square brackets are p-values.

With respect to risky behaviors, the results are also promising. It is predicted that a 1 p.p. increase (of the previous year) in the ratio of population who are daily smokers is accountable for 0.05 years decrease in life expectancy at age 65, everything else remaining constant. The corresponding negative impact of alcohol consumption is even more sizeable, showing a 0.16-year decrease in longevity for each additional liter consumed *per capita*. As expected, there is strong evidence that unhealthy habits are detrimental to life, especially for elderly people, as indicated by Lugo et *al*. (2013) and WHO (2017a).. Both negative effects are statistically significant at the highest 1% level. Furthermore, *CO2* emissions contributing to atmospheric pollution, negatively affect the elderly's life, despite its significance only verified in the OLS and RE cases only. This is an interesting result since there is little empirical support considering this issue in the literature and our study aims to contribute in this domain.

Finally, we were not able to find evidence that supply health factors given by the density of medical practitioners, and the demographic structure captured by the proportion of population aged 65 and over, are important factors in explaining longevity. Furthermore, the dummy variable capturing the financial recession in 2008 (*d2008*), although having the expected negative impact on life expectancy, is statistically insignificant.

5. Robustness check with interaction terms

As shown in Table 3, the proportion of population with age 65 and over (*ratio65*) did not display statistical significance except in the case of the OLS estimation where differences among countries are not controlled for. As explained in section 3, the impact of the elderly population on longevity (life expectancy at age 65) will depend on income conditions and on the educational level of this population group, as well as on health care provision measured in this study by pharmaceutical expenditures *per capita*. To test these hypotheses, we have re-estimated the health equation as given in Equation (1), introducing this time interaction terms: (i) between the elderly population ratio and the income variable, (ii) between the elderly population ratio and education, and (iii) between the elderly population ratio and *per capita* pharmaceutical expenditures. Running new regressions introducing alternatively the interaction terms indicated, it was shown that only case (iii) was relevant[17], and these results are reported in Table 4.

Table 4. Estimation results of life expectancy at age 65 with interaction term. European Union countries, 1990-2016.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	OLS	FE	RE	OLS-ROB	FE-ROB	RE-ROB
***ln(gdppc)**$_{i,t-1}$*	1.8906***	2.2721**	2.5436***	1.8906**	2.2721**	2.5436***
	(6.300)	(2.590)	(4.637)	(2.643)	(2.360)	(4.137)
***educ**$_{i,t-1}$*	-0.0179***	0.0426***	0.0212***	-0.0179	0.0426***	0.0212***
	(-3.138)	(5.126)	(3.234)	(-1.175)	(8.047)	(2.654)
***pop65**$_{i,t-1}$*	0.5699**	0.1768	0.2711	0.5699	0.1768	0.2711*
	(1.985)	(1.069)	(1.602)	(1.423)	(1.347)	(1.866)
***ln(pharspend)*pop65**$_{i,t-1}$*	-0.0682	-0.0135	-0.0333	-0.0682	-0.0135	-0.0333*
	(-1.489)	(-0.533)	(-1.293)	(-1.098)	(-0.727)	(-1.850)
***dailysmoker**$_{i,t-1}$*	-0.0474**	-0.0601***	-0.0415***	-0.0474	-0.0601***	-0.0415***
	(-2.523)	(-3.956)	(-2.829)	(-1.350)	(-4.607)	(-3.440)
***alcohol**$_{i,t-1}$*	-0.0626	-0.1805***	-0.1739***	-0.0626	-0.1805***	-0.1739***
	(-1.533)	(-4.437)	(-4.804)	(-1.031)	(-5.093)	(-6.208)
***ln(pharspend)**$_{i,t-1}$*	2.2468***	1.2199**	1.7675***	2.2468*	1.2199**	1.7675***
	(2.717)	(2.609)	(3.926)	(1.978)	(2.695)	(4.462)
***genpract**$_{i,t-1}$*	1.0497***	-0.5248	0.5228	1.0497**	-0.5248	0.5228
	(5.843)	(-1.123)	(1.611)	(2.676)	(-1.727)	(1.595)
***CO2**$_{i,t-1}$*	-0.0776***	-0.0336	-0.0795***	-0.0776	-0.0336	-0.0795**
	(-3.944)	(-1.090)	(-2.828)	(-1.600)	(-0.952)	(-1.998)
d2008	0.0778	-0.0140	-0.0252	0.0778	-0.0140	-0.0252
	(0.320)	(-0.119)	(-0.212)	(0.576)	(-0.146)	(-0.357)
Constant	-13.8474**	-12.7547	-17.6724***	-13.8474	-12.7547	-17.6724***

[17] Regression results referred to cases (i) and (ii) can be provided upon request.

	(1)	(2)	(3)	(4)	(5)	(6)
	(-2.414)	(-1.595)	(-3.239)	(-1.448)	(-1.658)	(-3.756)
Observations	147	147	147	147	147	147
N. of countries	19	19	19	19	19	19
F-test	45.38[0.00]	121.81[0.00]		43.97[0.00]	1501.20[0.00]	
χ^2			1072.63[0.00]			4042.48[0.00]
R^2	0.769	0.912	0.904	0.769	0.912	0.904
θ_min/max			0.651/0.915			0.651/0.915
BP/CW hetero. test	x_1^2=3.64[0.056]					
Wooldridge AR test	$F_{(1,8)}$ = 27.57 [0.001]					
Hausman test		X_{10}^2=20.82[0.022]				
BP LM test for RE			x_1^2=96.03[0.00]			

Note: ***,**, * - Coefficient significant at the 1%, 5% and 10% level, respectively. Numbers in parentheses are t-ratios. Numbers in square brackets are p-values.

In general, the results of the health equation with interaction term confirm the main findings of Table 3, both in terms of the estimates and the statistical significance of the covariates. Once more, the most efficient estimation is based on the Random Effects Model with robust standard errors given in column (6). Thus, we focus on those results and observe the following: (i) the interaction term between the ratio of elderly population and pharmaceutical expenditures is statistically significant at the 10% level, (ii) the ratio of elderly in total population (*pop65*) gains statistical significance at the 10% level, with the expected positive impact on longevity; (iii) air pollution (CO_2) displays statistical significance at the 5% level, with the expected negative sign.

The impact of the age structure on life expectancy at age 65 is now given as follows:

$$\partial le65_{it}/\partial pop65_{i,t-1} = 0.2711-0.0333\ ln(pharspend)_{i,t-1}$$

On average terms, the impact of age structure (*pop65*) over life expectancy depends on the level of pharmaceutical expenditures. The direct impact is positive, though the overall magnitude is dependent on pharmaceutical expenditures, *i.e*, for each additional increase in this expenditure, the overall impact of the ratio of elderly population on life expectancy declines. Using the average pharmaceutical expenditure 377.806 (see Table 1), the impact of *pop65* on life expectancy is positive and equivalent to a 0.074-year increase. With the lowest value 122.9 the impact is 0.11-year increase in life expectancy while the maximum value of 980 indicates an increase of 0.042 years in life expectancy. Higher spending on medication is often related to the existence of chronic conditions that imply the regular use of medication. These expenditures are likely to increase with age and are commonly connected to poorer health. There is evidence that per capita health care expenditures in the EU countries are higher at later stages of life, although performances differ across countries (Cylus et al, 2018).

Analogously, the impact of *per capita* pharmaceutical expenditures on life expectancy at age 65 is given as follows:

$\partial le65_{it}/\partial ln(pharspend)_{i,t-1}$=1.7675-0.0333 $pop65_{i,t-1}$

As it is shown, an increase in *per capita* pharmaceutical expenditure will in principle be associated with an increase in life expectancy, though it decreases as the proportion of the elderly gets higher. Using the mean value of the elderly population share (16.45%), it is predicted that the marginal impact of *ln(pharspend)* on life expectancy is a 1.22-year increase. With the minimum value of the elderly population share (13.2%) the impact of pharmaceutical expenditure on life expectancy is a 1.33-year increase while the maximum value 21.7% reveals a lower impact as expected, accounted for a 1.04-year increase in life expectancy.

Therefore, whereas the proportion of elderly population alone is not relevant for explaining life expectancy at 65, as it was shown in Table 3, when interacted with health care (through *per capita* pharmaceutical expenditures) it gains statistical importance in explaining longevity in the EU countries. This is in line with Shaw *et al.* (2005) who claim that ignoring the correlation between pharmaceutical consumption and a country's age distribution creates an omitted variable bias in the coefficient of pharmaceutical consumption, thus undervaluing the marginal effect of drug consumption on health.

Another gain is related to CO2 emissions variable that becomes statistically significant, revealing that a unitary increase (tones *per capita*) in the previous year will enhance a 0.08-year decrease in life expectancy at age 65. Therefore, the impact of air pollution becomes more expressive, stressing the importance of environmental conditions on the health status. Evidence is not clear that the density of generalist medical practitioners contributes significantly in expanding late life expectancy, except in the OLS estimation approach.

6. Conclusions

In this paper we try to identify the main factors explaining life expectancy at age 65 in a set of 20 EU countries using panel data over the period 1990-2016. By considering life expectancy at late age we corroborate the idea that health is the outcome of multifactorial effects. In this context, a health equation is estimated using socioeconomic, demographic, lifestyle, health care provision and environment quality factors to explain longevity in these countries. It is shown that income and education levels make an important contribution in prolonging life expectancy at a late age. Risky lifestyle habits such as smoking and alcohol consumption are detrimental to health, reducing life expectancy at the late stage of age. Atmospheric pollution through *CO2* emissions is also harmful to health and responsible for life expectancy reduction of the elderlies. This evidence makes a valuable contribution since this issue has not been explored sufficiently in the existing literature. Population structure proxied by the proportion of the elderly group is important in explaining life expectancy only in conjunction with health care provision given by the pharmaceutical expenditures *per* head. Evidence is not strong enough that health resources measured by the density of generic practitioners are important in explaining life expectancy.

Policies should be mostly directed to alter unhealthy behaviors through taxation, education and better information. Policies to improve economic conditions are crucial for longer and healthier life of the populations, especially at the late age. Better education is associated with health literacy that helps to understand the need for health care and avoiding unhealthy styles of life. Incentives to increase the birth rates contribute to change the population structure towards a younger generation able to reduce the costs of sustaining the elderly generations.

Policies to reduce atmospheric pollution (renewable energy, recycling, changing consumption habits) are also beneficial to health prolonging population's life and avoiding serious diseases or climate calamities. Financial resources should be provided to elderly people to facilitate access to medicines and treatments in order to live longer and with better life quality.

The productivity of elderly people is also important, being connected to health and education. Having overall more productive people (younger and older) is beneficial to ensure sustainable development. Efforts should be made to increase not only life expectancy but to improve the health status of elderly people offering opportunities in the labour market to allow for a more active and inclusive ageing process.

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Appendix

Table A1. List of the 20 European Union countries involved in the regressions

Austria (1)	Ireland (1)
Belgium (3)	Italy (4)
Czech Republic (9)	Latvia (2)
Denmark (15)	Luxembourg (14)
Estonia (8)	Netherlands (17)
Finland (11)	Portugal (2)
France (15)	Slovenia (2)
Germany (7)	Spain (3)
Greece (1)	Sweden (15)
Hungary (1)	United Kingdom (19)

Note: number of time periods for each country in parentheses

Table A2. Variables, Description and Data Sources

Variable	Description	Data Source
le65	Life expectancy (in years) at age 65	PORDATA - Data extracted on 19 Mar 2018
gdppc	Gross domestic product (expenditure approach), *per* head, constant prices, constant PPPs, OECD base year	OECD.Stat, Gross Domestic Product – - Data extracted on 26 Mar 2018
educ	Population that completed, at least, secondary school (ISCED 3 or more) as % of population aged 25-64	PORDATA – Data extracted on 27 Apr 2018
pop65	Population aged 65 and over as % of total population	OECD.Stat, Demographic References - Data extracted on 23 Mar 2018
dailysmoker	% of population aged 15+ who are daily smokers	OECD.Stat, Non-Medical Determinants of Health - Data extracted on 23 Mar 2018
alcohol	Liters per capita (15+)	OECD.Stat, Non-Medical Determinants of Health - Data extracted on 23 Mar 2018
pharspend	Total pharmaceutical sales *per capita*, US$ PPPs	OECD.Stat, Non-Medical Determinants of Health - Data extracted on 23 Mar 2018
genpract	Generalist medical practitioners, Density per 1 000 population (head counts)	OECD.Stat, Health Care Resources - Data extracted on 23 Mar 2018
CO2	CO2 emissions *per capita* in tons (t CO2eq)	PORDATA – Data extracted on 29 May 2018
d2008	Dummy =1 for the year 2008; 0 otherwise	Computed by the authors