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Retirement Transitions and Health Outcomes - A Panel Study using SHARE Data

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Abstract

A growing ageing population and pressures on the public pension system have opened up a conversation on how to best care for the elderly, but also the financial realities of supporting them through retirement. With many countries either considering to implement, or having already implemented increases in pension eligibility ages, a relevant question is then how this impacts the health and well-being of those affected, and through which mechanisms these changes occur. This paper utilises data from the Survey of Health, Ageing, and Retirement in Europe (SHARE[1]), and fixed-effects and instrumental variable strategy which uses ordinary retirement ages as an instrument for retirement. Retirement is found to improve self-rated health and activities of daily living, which may be due to a simultaneous increase in exercise. Estimates from heterogeneity analysis and robustness checks are presented. It is also concluded that key variables are sensitive to the choice of econometric model.

Key words: Retirement, Health, Health behaviours, Instrumental variable, Fixed effects, SHARE

[1] *This paper uses data from SHARE Waves 1, 2, 4, 5, 6, and 7. (DOIs: 10.6103/SHARE.w1.800, 10.6103/SHARE.w2.800, 10.6103/SHARE.w4.800, 10.6103/SHARE.w5.800, 10.6103/SHARE.w6.800, 10.6103/SHARE.w7.800) see Börsch-Supan et al. (2013) for methodological details.(1) The SHARE data collection has been funded by the European Commission, DG RTD through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812), FP7 (SHARE-PREP: GA N°211909, SHARE-LEAP: GA N°227822, SHARE M4: GA N°261982, DASISH: GA N°283646) and Horizon 2020 (SHARE-DEV3: GA N°676536, SHARE-COHESION: GA N°870628, SERISS: GA N°654221, SSHOC: GA N°823782, SHARE-COVID19: GA N°101015924) and by DG Employment, Social Affairs & Inclusion through VS 2015/0195, VS 2016/0135, VS 2018/0285, VS 2019/0332, and VS 2020/0313. Additional funding from the German Ministry of Education and Research, the Max Planck Society for the Advancement of Science, the U.S. National Institute on Aging (U01_AG09740-13S2, P01_AG005842, P01_AG08291, P30_AG12815, R21_AG025169, Y1-AG-4553-01, IAG_BSR06-11, OGHA_04-064, HHSN271201300071C, RAG052527A) and from various national funding sources is gratefully acknowledged (see www.share-project.org).*

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1. Introduction

An ageing population indicates progress in many ways, including the improvement of living conditions, better sanitary practices and medical treatments, and greater access to education and family planning (United Nations, 2023). However, an ageing population also has effects on the overall economy as working-age people increase their payments to support the older population, and an increased strain on the public budget due to the increased total health costs and retirement programs (Lee and Mason, 2017). Even after subtracting from what is covered by taxes paid by the elderly, pension transfers, healthcare, and long-term care make up for large portions of public budgets. Some argue that these programmes will soon be unsustainable unless either taxes are raised or benefits reduced, or a combination of the two (Lee and Mason, 2017).

As a result, pension reforms are underway in several OECD countries which increase the age eligible for pension benefits to alleviate the burden of public retirement systems. However, these changes may also have important effects on the health of future retirees, their healthcare utilisation, and subsequent changes healthcare costs. Retirement changes how an individual allocates their time, health risk exposure, and how they conduct their lifestyle (Bloemen et al., 2017). Early research on the topic concluded retirement to be a stressful event with adverse effects on health, as it leads to an interruption in activities, a change of identity, and a reduction in income (Minkler, 1981). If this were the case then delaying the ordinary retirement age would serve the dual purpose of improving the sustainability of the pension system, while also improving the health of the elderly population. However, if retirement has the opposite effect on health, it becomes more of a balancing act of prioritising the financial burden or the negative impact prolonged working has on health.

However, due to the endogenous nature of retiring, more recent studies have yielded positive, negative, and zero effects on health. These vastly different results could be due to a variety of reasons, including the data set used, which time period studied, and the empirical approach they chose to employ. This paper will use data from the Survey of Health, Ageing, and Retirement in Europe (SHARE), and will utilise the approach of some recent articles, which is individual fixed effects and two-stage least squared, which exploits variations within-entity and between-entity, and addresses multiple sources of endogeneity. It utilises the exogenous variability in ordinary retirement ages in different European countries as an instrument for retirement, as crossing the age for pension benefits provides a financial incentive to retire.

This paper contributes to the literature in a few different ways. Firstly, by further exploring the effects of retirement on our ageing population in Europe through the use of more recent data waves and a longer panel. Secondly, by also presenting estimates for changes in health behaviours, in order to establish mechanisms through which the changes in health are implemented. Thirdly, by presenting estimates from four different empirical models in order to determine how sensitive the analysis is to chosen methodology.

The paper is organised as follows: chapter 2 provides an overview of relevant literature on the topic at hand, chapter 3 gives a brief introduction to the Grossman Model of Health Demand as the theoretical framing of this research, chapter 4 organises the data sample used for this analysis, and chapter 5 explains the empirical approach of the paper. Results are presented in chapter 6, as well as the heterogeneity analysis, while robustness checks are performed in chapter 7. A discussion of the results can be found in chapter 8, and the paper ends with concluding remarks in chapter 9.

2. Literature Review

The discourse surrounding the fiscal burden of a public pension system and subsequent discussions of policy changes have sparked an academic debate on the effect retirement has on the health of the elderly. The initial literature hypothesised that retirement would negatively affect health due to the belief that working maintains physical and mental activity. This line of thinking also agreed with literature from labour economics which determined involuntary unemployment to adversely affect health. Proposals to extend the state pension age would then serve a dual purpose by alleviating the pressure on state funds from both pension transfer payments and medical costs for the older population. An overview of the early thoughts and literature on the topic can be found by Minkler (1981). However, as pointed out by Hallberg et al. (2015), retirement in contrast to losing a job is voluntary in the majority of cases, and may thus circumvent the stress of an uncertain future and the social stigma of unemployment. Retirement opens up more time to address health upkeep, while also limting stress and strain (Insler, 2014) In this case, it is possible that retirement has a positive effect on health, and thus the savings from extending the pension age may be counteracted through increased medical spending. Furthermore, it raises ethical concerns about imposing additional health burdens on an already vulnerable population.

Much of the initial work on health and retirement explored how health influences retirement decisions, Dave et al. (2006) were some of the first to switch perspectives by examining how retirement affects health. Using the Health and Retirement Study, they accounted for endogeneity with fixed effects and specification checks and found that retirement led to a 5-14 per cent increase in mobility and daily living difficulties, a 4-6 per cent increase in illnesses, and a 6-9 per cent decline in mental health. However, they also estimated that 80-90 per cent of the effect could be attributed to non-random selection and unaccounted-for endogeneity. Early studies on the topic struggled to account for the inherent endogeneity of the retirement decision, namely that individuals with poorer health tended to retire early (Neuman, 2008). Consequently, retirement may seem to be the culprit of health deterioration, while the true cause could be unobserved factors influencing the timing of retirement. Subsequent research aimed to address endogeneity through various panel data models, in addition to using different indicators for the dependent variable *health*.

To mitigate the endogeneity issue, Neuman (2008) utilised an instrumental variable approach, using exogenous variations in public and private pensions. Analysing the Health and Retirement Study, they found that subjective measures of health significantly improved post-retirement, while objective health measures (diagnoses of various illnesses and conditions) showed improvement, but were ultimately deemed statistically insignificant. Coe and Lindeboom (2008) continued using Social Security benefits as an instrument for retirement, and similarly to Neuman (2008) found statistically significant improvement in subjective health for men, with a 30 per cent increase in the probability of reporting "good health", with no negative effects found for objective health measures. Johnston and Lee (2009) took a different approach and used Regression Discontinuity on pooled data from Health Survey for England. However, this change in methodology did not lead to a change in conclusions, as subjective health measures improved post-retirement while objective measure remained insignificant. The results suggest that retirement may conserve or even improve health, but the lack of significance for objective health variables indicates that the preservation is more imaginary than real. Johnston and Lee (2009) hypothesised that retirement eliminates work-related stress while also opening up time for relaxing activities which would be reflected in self-rated health, but not necessarily when estimating objective changes in health.

Gorry et al. (2018) built on the work performed by Coe and Lindeboom (2008) and Neuman (2008) and used instrumental variables to study self-rated health and number of health conditions. Their Ordinary Least Squares (OLS) baseline estimation saw no change in self-rated health but a significant increase in number of health conditions. When using IV, however, they found a significant increase in self-rated health, mental health, and life satisfaction. The improvements were sustained for several years following retirement and were not attributed to increased healthcare utilisation. These results further indicate that the negative findings on health found in early literature might be the consequent of not adequately accounting for endogeneity.

A well-cited study from Coe and Zamarro (2011) used data from the *Survey of Health, Retirement, and Ageing in Europe* (SHARE) and also found more optimistic results of health post-retirement. Using OLS as a baseline, the initial estimates showed a 14 per cent *increase* in the probability of reporting “bad health”, while the IV estimated a 35 per cent *decrease* in the probability of reporting “bad health”, consistent with previous findings by Coe and Lindeboom (2008). In addition to self-reported health, they constructed a health index using objective health measures which showed health to improve by one standard deviation from retirement. The results from the health index were however only significant at the 10 per cent level. Additionally, while previous work had used longitudinal data, this study was limited by its use of a single cross-section of data, leaving uncertainty about the validity of the derived results.

More recent research has also focused on specific aspects of health in regards to retirement, such as morbidity (Godard, 2016), mortality (Bloemen et al., 2017; Hallberg et al., 2015; Fitzpatrick and Moore, 2018), and overnight stays at hospital (Hallberg et al., 2015). Bloemen et al. (2017) used mortality as the dependent variable of interest, more specifically the probability of death within five years of retirement. This was made possible through a temporary offer of early retirement for civil servants in the Netherlands, where civil servants between the ages 53 and 54 were used as the control group, and 55 to 60 as the treatment group. Using IV they found that early retirement decreased the probability of dying within 1 year by 92 per cent, and within 5 years by 47.1 per cent (or 2.6 percentage points). Hallberg et al. (2015) also utilised early retirement offers in the Swedish military and employed a difference-in-difference methodology, and found both mortality and inpatient days to decrease as a response to the offer of early retirement.

However, it would be inaccurate to blame the negative results from early literature only on unaccounted-for endogeneity. Godard (2016) used SHARE data and combined approach of IV and fixed effects and found significant results that retirement increased both BMI value and probability of being obese. Behncke (2011) used IV and propensity matching to study the effect on several conditions such as number of chronic illnesses, cardiovascular disease, BMI, cholesterol and blood pressure. They concluded that delaying retirement should not lead to increased healthcare spendings, and might in fact delay the onset of chronic conditions. It is however noteworthy to mention that they worked with a small sample, which could have influenced the results. Fitzpatrick and Moore (2018) also looked at the impact on mortality in the U.S using regression discontinuity, and concluded that the disruption in labour caused a 2 per cent increase in mortality for 62 year old men.

An additional curiosity is then what causes these changes in health. Dave et al. (2006) discussed how individuals have some degree of control over their health through a behavioural framework, including social interactions, physical activities, smoking, drinking, and diet. Eibich (2015) used financial incentives in the German pension system to identify the effect of retirement and found that retirement improved health measures, and identified reduced strain from work, improvements in sleep, and more frequent exercise as possible channels through which improvements in health may have materialised. Britton et al. (2008) studied factors of “succesful ageing” (being high-functioning and free from disease), and their analysis found that targeting health behaviours in early and mid-life benefited successful ageing, even after inequality in start of life such as poor education and financially disadvantaged parents. Celidoni and Rebba (2016) dedicated a paper on the topic using SHARE data and a FE-2SLS model, and found a causal effect of retirement on health behaviours, in particular physical exercise, and argued that it may be a key mechanism for health changes from retirement. Kesavayuth et al. (2018) followed up on this with a similar empirical approach, and found exercise and drinking to increase due to retirement and smoking to decrease, with all estimates being found significant.

3. Theoretical Background

The direction of health and health-related behaviour has so far proven to be ambiguous and contested, but what the literature has in common is the basis of the *Grossman Model of Health Demand*, which this paper is also framed around. In this model, Grossman (1972), defines health as a commodity, so that “good health” is something that individuals derive utility from and subsequently have a demand for, as well as a capital stock which itself produces an output of “healthy time”. When individuals are born they inherit a stock of health, which after some stage in their life cycle will begin to depreciate over time at an increasing rate, but can also be improved by investments by the individual.

As health is defined as both a consumption commodity and an investment commodity, there are two reasons for consumers to have a demand for health. As a consumption commodity, sick days will give the consumer disutility, as their bad health enters the preference function. While as an investment commodity, the number of healthy and sick days directly determines the time available for different activities, for example, working and earning money, which has an important effect on an individual’s level if wealth. (Grossman, 1972)

Due to the possibility of investing in one's health, individuals have some level of control over their level of health through behavioural mechanisms such as social interactions, activities and exercise, smoking and drinking, eating habits, and preventative healthcare (Dave, 2006). Retiring means a permanent exit from the labour market, which changes incentives to invest in health due to changes in wages and other earnings. One of the predictions made by Grossman (1972) is that medical care should be positively correlated with the wage, as the higher the wage, the higher the opportunity cost of sick days and missing work. Consequently, when considering health as an investment commodity, the lack of a health-dependent wage or salary will remove the incentive of keeping up health stock as it will not have an impact on one’s earnings (Gorry et al. (2015). On the other hand, the increase in leisure time also lowers the opportunity cost of health investments such as social interactions, exercise, and preparing nutritious meals (Eibich, 2015; Godard, 2016). According to this model the effect of retirement on health investments and subsquent health could then go in either direction.

In addition to wage incentives, education is also considered a causal effect in this model. It is assumed that education increases the efficiency in production of health from investments, which would mean that more educated individuals are both more knowledgeable when it comes to health upkeep, they also have a greater demand for health stock as education is correlated with higher earnings (Grossman, 1972). In an extended model, Galama et al. (2012) also predicts that more educated people that those with higher human capital retire later as they invest more in health and can thus work longer than those of lower human capital. Heterogenous effects due to education are therefore also of importance when studying health and retirement according to this model.

4. Data

4.1. SHARE

The data used in this paper is drawn from the *Survey of Health, Ageing, and Retirement in Europe* (SHARE), which is an interdisciplinary, cross-country survey, and coordinated by *Max-Planck-Institute for Social Law and Social Policy* and the *Munich Center for the Economics of Aging*. The survey is focused on people the age of 50 or older (as well as potential younger partners of participants) and provides microdata on a wide arrange of topics, including, but not limited to, health, socioeconomic status, and social and family networks. The survey is harmonised with other important databases such as the U.S Health and Retirement Study (HRS) and the English Longitudinal Study of Ageing (ELSA). The first wave was released in 2004 and collected data from eleven European countries, new waves have since then been released roughly every two years and at present cover 28 European countries as well as Israel, presented in eight survey waves, and two special COVID-19 surveys.

4.2. Sample

Due to the release of new waves and an extended time span, this paper has the opportunity to test the consistency of findings in previous research. Previous work using SHARE data has been mostly limited to the use of up to three waves, while this paper can utilise both newer data as well as a longer time span, to get an updated estimate of effects which also covers long-term effects. This paper uses data from six saves in total, waves 1, 2, 4, 5, 6, and 7, which were collected in the years 2004/2005, 2006/2007, 2011/ 2012, 2013, 2015, and 2017 respectively. Wave 3 is not included because it did not follow the regular format and asked retrospective questions rather than questions about present life conditions. The most recent wave (wave 8), is not included because it was interrupted by the COVID-19 pandemic which led to some data irregularities. Most notably, one part of the participants answered the survey before the pandemic and one part after the outbreak, consequently, the wave is excluded due to the vastly different conditions while undertaking the survey. Furthermore, several of our variables of interest were affected by the pandemic which would result in outlier data, for example:

1. The timing of retirement, due to the instability of the labour market
2. One's health, due to health consequences of being infected with COVID-19
3. Habits such as exercise, due to lockdown rules.

In order to be more comparable to other papers using SHARE data and to maintain continuity, only the countries that participated in all six waves will be used. We end up with 10 countries: Sweden, Belgium, Denmark, Italy, France, Spain, the Netherlands, Germany, Switzerland, and Austria. Observations where there was missing information in any of the explanatory variables where excluded from the final panel. All in all, we are left with 140,944 observations collected from 43,771 individuals, which included observations across all six waves where the individuals participated in at least 2 waves.

4.3. Retirement and Age

SHARE provides extensive data to define the age of the respondents. The reported age is the age the individual will or has already turned that year, however, this paper takes the extra step to calculate a more specific age. SHARE also gives the year and month that the respondent was born and and answered the survey, which provides the opportunity to calculate more accurate ages. While this is a good thing on its own due to increased accuracy, it is also important as some countries, for example Italy and Spain, have implemented policies to increase retirement age gradually in increments of months. In terms of working status, SHARE reports five different options: retired, employed or self-employed, unemployed, homemaker, and having permanently left the workforce from sickness or illness. We will use the most straightforward approach and only use observations that were retired or employed/self-employed, creating a dummy variable *retirement* which takes the value 1 if the individual is retired, and 0 if the individual is working.

4.4. Health

There are many different ways to define and measure health, and this paper utlises five indicators to measure health:

- ➢ Self-rated health - a measure which asks the participant to rate their health as either excellent, very good, good, fair, or poor.
- ➢ Activities of daily living (ADL) measures the ability of an individual to perform activities of self-care, such as bathing, grooming, dressing, total hygiene, functional mobility, and self-feeding.
- ➢ Body Mass Index (BMI) - an index that measures weight relative to height
- ➢ Chronic illnesses - a count variable representing the number of reported chronic illnesses
- ➢ Number of overnight stays at hospital - reflecting the frequency of hospitalisations

Self-rated health is a tricky variable as it is a subjective assessment of health, with the added possibility of different people assigning different meanings to descriptions such as good vs very good. This can especially become an issue in a cross-country survey such as this one where both cultural and linguistic interpretations may apply. In order to reduce the subjective interpretation of these definitions, a dummy variable is constructed taking the value 1 if a person reports very good or excellent health, and 0 if otherwise

These were picked as they often show up in this line of literature, providing both a subjective and objective view of an individual's well being, while also giving relatively well-encompassing idea of different aspects of health. These health measures were reported in all waves, and were thus collected from all six.

4.5. Behaviour and Habits

In order to examine mechanisms which cause potential changes in the above health measures, this study utilises five health behaviours: smoking. alcohol consumption, fruit and vegetable consumption, moderate exercise, and vigorous exercise. In this case not all variables were surveyed for each wave, and were thus collected from different sets of waves. Smoking is presented as a dummy variable taking the value 1 if the individual is a smoker at the time of the survey, and 0 if the individual is not. This data was collected from waves 1, 2, 4, and 5. There are several measures for alcohol consumption in the survey to choose from, and vary depending on wave. The one used in this instance, the respondent was asked to estimate on average how many days per week they consumed alcohol over the past six months. This dummy variable takes the value 1 if the individual drinks at least once per week, and the data was collected from waves 2, 4, and 5. For fruit and vegetables, the dummy takes the value 1 if the individual has one serving of fruit and vegetables at least three times per week and 0 otherwise, and this data was collected from waves 4, 5, and 6. Moderate and vigorous exercise measure different types of activities. Moderate exercise measures activities such as gardening, cleaning the car, or going on a walk, whereas vigorous exercise measures participation in sports or performing heavy housework. For both variables they take the value 1 if they participate in a corresponding activity at least once per week and 0 otherwise, and this data was collected from waves 1, 2, 4, 5, and 6.

4.6. Additional variables

In addition to the already explained variables, we also include dummy variables for partnership and the waves data is collected from. Having a partner may have an effect on health and behaviour through for example informal caregiving or the encouragement of healthy habits, while wave dummies are included to control for time-specific trends. The partner dummy takes the value 1 if the individual lives with their spouse or has a domestic partner, and 0 otherwise. ISCED codes for education levels and gender are also used to examine heterogenous effects, with highly educated here being defined as having completed a degree from a university of university college. The gender dummy in table 1 is defined as male=1 and female=0.

Table 1. Descriptive Statistics

	Full sample		Retiring between waves	
	Mean	Observations	Mean	Observations
Age	67.2	140,994	62.974	16,483
Gender	.513	140,994	.559	16,483
State pension age	64.001	140,994	64.104	16,483
Retirement	.667	140,994	.485	16,483
Partner	.717	140,994	.713	16,483
Hospital nights	1.467	140,994	.87	16,483
Activities of daily living	.169	140,994	.054	16,483
Self-rated health	.321	140,994	.426	16,483
Body mass index	26.387	140,994	26.347	16,483
Chronic illnesses	1.636	140,994	1.657	16,483
Fruit and vegetables	.950	88,637	.953	7,416
Smoking	.182	83,622	.197	7,810
Drinking	.368	75,142	.397	6,630
Moderate exercise	.852	119,234	.916	10,411
Vigorous exercise	.514	119,234	.643	10,411

5. Empirical Approach

When estimating the effect of retirement the estimates may be biased due to endogeneity, which would make the straightforward OLS an inappropriate approach. The first threat of endogeneity would be from insufficient use of control variables, which would lead to omitted variable bias and could affect both our retirement variable as well as our dependent variables. Furthermore, the timing of deciding to retire is not a random event but is dependent on multiple factors such as one's financial status, family situation, as well as present-time health, and a correlation between retirement and any of these variables could lead to biased estimates. There is also the risk of reverse causality, in which a correlation between the dependent- and independent variables are perceived to move in one direction, when the causality may in fact go in the opposite direction. Similarly, it might be that the two variables impact each other at the same time, known as simultaneity bias. That retirement has an effect on health, but also that the state of one's health influences the timing of entering retirement. In this case, it would be tricky to interpret the effect of one variable on the other. Finally, there is risk of biased coefficients due to measurement error in the independent variables. Consequently, using OLS, even with control variables, will likely yield biased estimates.

In order to circumvent this and get unbiased and consistent results, this paper will follow the methods used by Godard (2016) and Celidoni and Rebba (2016), and combine two regression models to account for multiple sources of endogeneity. To start off, consider the following linear panel data model where individuals are observed over various time periods:

$$H_{it} = X_{it}\beta + v_{it}$$

Where H_{it} is our independent variable (health and health-related habits), X_{it} is a vector of explanatory variables, and v_{it} is the error term. The error term can then be split into two parts, ε_{it} and η_i, in which η_i is individual-specific but time-invariant, which contains fixed factors such as gender, ethnicity, personality traits, and genetics, as well as other observable and unobservable traits. In this case, it is not assumed that the explanatory variables are uncorrelated with the error term, that is to say:

$$E(\eta_i | X_{i1}, X_{i2}, \dots, X_{iT}) \neq 0$$

However, this violation of the zero conditional mean assumption is solved by using *within estimation*, which will be done by employing a fixed effects model. This is done by estimating the individual-specific averages over time:

$$\overline{H}_i = \overline{X}_i\beta + \overline{\eta}_i + \overline{\varepsilon}_i$$

where each component is defined as:

$$\overline{Y}_i = \frac{1}{T}\sum_{t=1}^{T} Y_{it} \quad \overline{X}_i = \frac{1}{T}\sum_{t=1}^{T} X_{it} \quad \overline{\varepsilon}_i = \frac{1}{T}\sum_{t=1}^{T} \varepsilon_{it} \quad \overline{\eta}_i = \frac{1}{T}\sum_{t=1}^{T} \eta_i$$

Next step is to subtract each component with its average, and since $\overline{\eta}_i = \eta_i$, we are left with the following:

$$Y_{it} - \overline{Y}_i = (X_{it} - \overline{X}_i)\beta_{FE} + (\varepsilon_{it} - \overline{e}_i)$$

At this point, OLS is used to estimate β_{FE} coefficients. In summary, after removing the fixed effect component we have controlled for all observable and unobservable individual fixed factors, and β_{FE} captures within-subject change, rather than the variation between subjects. However, this may not be enough. Fixed effects still require the variable part of the error term to be uncorrelated with the explanatory variables and the fixed factor, i.e,

$$E(\varepsilon_{it} \mid X_{i1}, X_{i2}, \dots , X_{iT}, \eta_i) = 0$$

While fixed effects removes factors which vary across individuals but are constant over time and can thus remove a substantial amount of omitted variable bias, it will not eliminate any bias from time-variant sources. By extension, relying solely on fixed effects still leaves one vulnerable to time-varying omitted variable bias, simultaneity bias, and measurement error bias. We therefore find it necessary to exploit exogenous variability for unbiased estimates, and utilise an instrumental variable approach in addition to fixed effects. This exogenous variability is found by using countries' ordinary retirement age[2] as an instrument for actual retirement status, creating discontinuities in retirement probability. The countries in Europe have small variations in ordinary retirement age between countries, and in some countries differences depending on gender. The instrument was defined as:

$$Z_{ict} = 1(age_{it} > ORA_{ct})$$

Using this instrument, the two following equations are estimated:

$$Retirement_{itc} = \alpha_0 + \alpha_1 Z_{itc} + \alpha_2 X_{it} + \varepsilon_{itc}$$
$$H_{it} = \beta_o + \beta_1 \widehat{Retirement}_{itc} + \beta_2 X_{it} + v_{itc}$$

With the first equation and second equation being first and second stage respectively, i represents individual, t time, c country, X_{it} refer to the control variables used, and H represents health or health behaviour indicators. However, there are additional assumptions to be fulfilled for instrumental variable to fill the gaps from the already defined fixed effects.

[2] Retirement ages for waves 1, 2, and 3 were collected from Celidoni and Rebba (2016), for the remaining waves it was collected from a combination of the respective Pension Authority websites, OECD country profiles, and mentions in news articles.

Firstly, the relevance assumption, states that there is a first stage, meaning that the instrument and endogenous variable are related, i.e. Cov(z_i,x_i) ≠ 0. A stronger correlation signifies a stronger instrument, meaning that the instrument is a better predictor for the endogenous variable. In this case the assumption seems reasonably true, as pension eligibility provides a financial incentive for people to retire.

Secondly, the independence assumption, is it assumed that the instrument is as good as randomly assigned. Similarly to the error term in fixed effects, the endogenous variable can be imagined as two parts, one problematic part and one unproblematic part. The instrument provides variation through an effect on the unproblematic part, which provides an essentially random assignment of treatment. In this case exogenous variation in ordinary retirement age is used, and it seems reasonable that the assumption will be fulfilled, as pension eligibility is a government-made decision separate from an individual's health or habit. This assumption ensures that the results from the second stage gives a causal estimate of retirement on health and health habits. (Angrist and Pischke, 2009)

Thirdly, monotonicity, which states that the instrument has an identical effect on all those affected. This assumption essentially removes the option for defiers in the sample, so no people will retire before reaching the state pension age, only to start working after reaching said age. (Angrist and Pischke, 2009)

Lastly, the exclusion restriction assumes the instrument is not related to any observable or unobservable determining factors of the dependent variable. This means that on its own the instrument does not have an impact on the dependent variable of interest, but only through its connection to the endogenous variable, and can thus be excluded from the equation without leading to omitted variable bias (Angrist and Pischke, 2009). An example of a violation would be if socioeconomic status affected the probability of being assigned a certain retirement age, which might have been the case if we used early retirement age, as it can be tied to one's type of employment. This should however not be an issue as the ordinary retirement age is statewide.

The existence of a first stage is easy enough to test for, we simply perform an F-test to check if the instrument adequately predicts the endogenous variable. The rule of thumb is suggested by Staiger and Stock (1997), is that an instrument is sufficiently strong to not yield biased results if an F-statistic of F>10 is derived. F-statistics will be reported in the results tables, and they are all substantially above the value of 10, indicating that the first-stage assumption is fulfilled. The exclusion assumption however cannot be tested, as it would require that one tests the correlation between the instrument and the error term. However, as the error term is unobservable, this is not possible, and so one instead has to rely on economic theory and by consulting literature.

Combining these two methods, our models offers several advantages for our panel analysis. It addresses endogeneity of multiple sources, reducing the bias of our affected variables. Additionally, our estimates may be more precise due to the use of both within-entity and between-entity variations, ensuring reliable results for the estimates.

6. Results

6.1. Preliminary Results

Since the main method of this paper is the combined FE-2SLS, the estimates for fixed effects and two-stage least squares will be presented first to examine to what extent the estimates can be attributed to each model. In addition to these estimates, results from OLS regressions will be presented to examine what is gained from employing other models to account for endogeneity. The OLS estimates for both sets of indicators will be presented on their own in table 2, the estimates using fixed effects and 2SLS separately will be presented together, in table 3 for health indicators, and table 4 for behaviour indicators. The estimates for both sets of indicators from FE-2SLS are then presented together in tables 5.

Results from OLS on the effect of retirement are all highly statistically significant except for the effect on the number of chronic illnesses or drinking frequency. The remaining estimates all across the board suggest that retirement has a negative impact on both health and health behaviour, as hospitalisation increases, ADL, and BMI increase, while probability of rating oneself as having very good or excellent health decreases by 12.8 percentage points. Probability of consuming greens and smoking see a small decrease and increase respectively, and probability of both moderate and vigorous exercise decrease, but with a substantially larger impact on vigorous exercise.

Table 2. OLS effect of retirement in health and health-related behaviour

VARIABLES	(1) Hospital nights	(2) Activities of daily living	(3) Self-rated health	(4) Body Mass Index	(5) Chronic illnesses	(6) Fruit and vegetables	(7) Smoking	(8) Drinking	(9) Moderate exercise	(10) Vigorous exercise
Retirement	0.709***	0.0632***	-0.128***	0.675***	-0.0135	-0.0118***	0.0116**	0.000948	-0.0116***	-0.109***
	(0.0551)	(0.00532)	(0.00537)	(0.0578)	(0.0141)	(0.00322)	(0.00591)	(0.00681)	(0.00339)	(0.00558)
Age	-0.186***	-0.106***	0.00880***	0.343***	0.00390	0.00419***	-0.0118***	0.0336***	0.0453***	0.0361***
	(0.0247)	(0.00416)	(0.00204)	(0.0224)	(0.00539)	(0.00130)	(0.00224)	(0.00256)	(0.00159)	(0.00200)
Age^2	0.00175***	0.000871***	-0.000110***	-0.00272***	-2.54e-05	-2.33e-05***	2.96e-05*	-0.000239***	-0.000382***	-0.000337***
	(0.000182)	(3.17e-05)	(1.41e-05)	(0.000156)	(3.77e-05)	(8.99e-06)	(1.55e-05)	(1.82e-05)	(1.17e-05)	(1.39e-05)
Partner	-0.0484	-0.00576	0.00646**	-0.0302	-0.329***	-0.00535***	0.0128***	-0.0199***	-0.00448***	-0.00949***
	(0.0436)	(0.00422)	(0.00286)	(0.0281)	(0.00955)	(0.000565)	(0.00102)	(0.00118)	(0.000719)	(0.000943)
Wave dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Constant	5.342***	3.213***	0.325***	15.38***	1.774***	0.790***	0.779***	-0.724***	-0.408***	-0.272***
	(0.816)	(0.134)	(0.0705)	(0.773)	(0.185)	(0.0449)	(0.0776)	(0.0868)	(0.0526)	(0.0686)
Observations	140,994	140,994	140,994	140,994	140,994	88,637	83,622	75,142	119,234	119,234
Number of id	43,771	43,771	43,771	43,771	43,771	40,797	36,468	41,496	44,217	44,217
R-squared	0.013	0.070	0.058	0.012	0.010	0.003	0.036	0.012	0.061	0.086

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The estimates for health indicators turn out to give some mixed results from fixed effects. Nights spent at hospitals and BMI increase slightly, indicating a worsening in health, while ADL, number of chronic illnesses, and probability of reporting very good or excellent health, improve. However, only the decrease in ADL is statistically significant at the 5 per cent level, while the increased probability of reporting good health is marginally significant at the 10 per cent level (p-value around 0.054).

When using 2SLS we come to some different conclusions, most notably, the effect on chronic illnesses and self-rated health switched signs, to retirement increasing the number of chronic illnesses and decreasing self-rated health. Additionally, all indicators are statistically significant, with the increase in BMI at the 5 per cent level, and all others at the 1 per cent level. The only measure that indicates a positive impact on health from retirement is ADL, suggesting that retirement has an overall negative effect on health. However, the probability of self-rated health being very good or excellent decreasing 7.94 percentage points is curious, as previous studies have consistently derived a positive and significant effect of retirement on subjective health. This could be an indication that the model was incorrectly specified.

A quick glance at fixed effects estimates shows that the impact on vegetables and fruit is essentially zero, while the probability of engaging in moderate exercise increases by 2.74 percentage points, and vigorous exercise decreases by 1.16 percentage points. Smoking decreases by less than 1 percentage point, while regular drinking increases by 3.75 percentage point. However, only moderate exercise and drinking are significant at the 1 per cent level, with smoking being marginally significant at the 10 per cent level.

Similarly to when looking at health indicators, 2SLS estimation postulates that retirement has a statistically significant effect on all behaviours and habits, with vegetables being significant at the 5 per cent level, and all other habits are significant at the 1 per cent level. The probability of eating vegetables and fruit at least three times a week increases by 1.63 percentage points, moderate exercise increases by 3.77 percentage points, vigorous exercise decreases by 9.54 percentage points, and smoking and drinking decrease by 5.73 and 8.44 points respectively. According to 2SLS, besides vigorous exercise, retirees improve their lifestyles, so it is intriguing why we then estimate worse health outcomes.

Table 3. FE and 2SLS effect of retirement on health

	Hospital nights		Activities of daily living		Self-rated health		Body mass index		Chronic illnesses	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	FE	2SLS	FE	2SLS	FE	2SLS	FE	2SLS	FE	2SLS
Retirement	0.0157	0.419***	-0.0125**	-0.0779***	0.0111*	-0.0794***	0.0354	0.329**	-0.00910	0.0975***
	(0.0789)	(0.136)	(0.00542)	(0.0127)	(0.00575)	(0.0124)	(0.0256)	(0.129)	(0.0222)	(0.0351)
Age	-0.137	-0.130***	-0.179***	-0.0787***	0.0174***	-0.000575	0.334***	0.409***	0.0192	-0.0175**
	(0.116)	(0.0302)	(0.00940)	(0.00398)	(0.00620)	(0.00299)	(0.0312)	(0.0314)	(0.0252)	(0.00811)
Age^2	0.00344***	0.00142***	0.00117***	0.000707***	-3.06e-05	-5.32e-05***	-0.00296***	-0.00313***	5.24e-06	0.000104**
	(0.000339)	(0.000205)	(4.15e-05)	(2.99e-05)	(1.95e-05)	(1.94e-05)	(0.000108)	(0.000204)	(7.87e-05)	(5.24e-05)
Partner	-0.0544	-0.0490	-0.00625	-0.00604	0.00225	0.00655**	0.00288	-0.0309	-0.355***	-0.328***
	(0.0515)	(0.0436)	(0.00395)	(0.00423)	(0.00267)	(0.00287)	(0.0128)	(0.0282)	(0.0119)	(0.00955)
Wave dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Constant	-3.441	3.355***	6.489***	2.245***	-0.505	0.659***	16.98***	13.00***	0.763	2.536***
	(6.534)	(1.034)	(0.501)	(0.130)	(0.343)	(0.105)	(1.705)	(1.097)	(1.401)	(0.284)
First stage F-score										
Observations	140,994	140,994	140,994	140,994	140,994	140,994	140,994	140,994	140,994	140,994
Number of id	43,771	43,771	43,771	43,771	43,771	43,771	43,771	43,771	43,771	43,771
R-squared	0.004	0.012	0.040	0.066	0.019	0.057	0.015	0.012	0.011	0.009

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4. FE and 2SLS Retirement effect on health-related behaviour

	Fruit & vegeetables		**Smoking**		**Drinking**		**Moderate exercise**		**Vigorous exercise**	
	FE	2SLS	FE	2SLS	FE	2SLS	FE	2SLS	FE	2SLS
Retirement	-6.38e-05	0.0163**	-0.00863*	-0.0573***	0.0375***	-0.0844***	0.0274***	0.0377***	-0.0116	-0.0954***
	(0.00382)	(0.00742)	(0.00512)	(0.0143)	(0.00865)	(0.0168)	(0.00461)	(0.00839)	(0.00758)	(0.0134)
Age	0.00464	-0.000144	-0.0247***	-0.00140	0.0374***	0.0540***	0.0676***	0.0369***	0.0546***	0.0355***
	(0.00441)	(0.00189)	(0.00462)	(0.00350)	(0.0103)	(0.00384)	(0.00556)	(0.00198)	(0.00746)	(0.00302)
Age^2	-7.39e-06	9.97e-09	8.92e-05***	-2.59e-05	-0.000192***	-0.000374***	-0.000530***	-0.000334***	-0.000369***	-0.000339***
	(2.17e-05)	(1.23e-05)	(1.72e-05)	(2.27e-05)	(3.45e-05)	(2.51e-05)	(2.07e-05)	(1.34e-05)	(2.52e-05)	(1.95e-05)
Partner	0.0076	0.02412***	-0.0188**	-.0568***	0.0227	0.0794***	-0.00989	0.0193***	0.0113	0.0414***
	(0 .0069)	(0.00241)	(0.0074)	(0.0044)	(0.0149)	(0.00501)	0.0091	(0.00294)	0.0114	(0.0040)
Wave dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
								(0.00330)		(0.00476)
Constant	0.670***	0.943***	1.375***	0.415***	-1.208**	-1.458***	-1.221***	-0.111	-1.325***	-0.254**
	(0.242)	(0.0663)	(0.252)	(0.122)	(0.587)	(0.134)	(0.304)	(0.0681)	(0.414)	(0.106)
Observations	88,637	88,637	83,622	83,622	75,142	75,142	119,234	119,234	119,234	119,234
Number of id	40,797	40,797	36,468	44,217	41,496	44,217	44,217	36,468	44,217	41,496
R-squared	0.002	0.0019	0.005	0.0337	0.003	0.0087	0.024	0.059	0.012	0.085

Clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The combined approach provides estimates somewhere in between. As with fixed effects, for FE-2SLS only ADL and self-rated health have statistically significant results, with both indicators being improved by retirement. Hospital nights decline, while BMI and chronic illnesses increase, however they are not significant. For ADL and self-rated health the significance levels have improved from fixed effects and are now significant at the 1 per cent level. The magnitude of self-rated health is of a similar magnitude to 2SLS but with a positive sign, which is more consistent with previous literature. The size for ADL is slightly bigger when using FE-IV than when just using IV, but still has the same sign. The effect on BMI diminishes to about a third and for chronic illnesses it goes down a bit. Also consistent with previous literature is the lack of significance in more objective health measures.

As with the health indicators, the effect on health behaviour ends up somewhere in between fixed effects and 2SLS on their own. Probability of frequent vegetable intake decreases by 0.7 percentage points and probability of smoking decreases by 2.57 points, although both statistically insignificant. Probability of frequent drinking increases by 4.84 percentage points, but is only marginally significant at the 10 per cent level. Furthermore, exercise, both moderate and vigorous, increase in probability by 8.69 and 6.41 points respectively, and both significant at the 1 per cent level. Something particularly interesting about these results is that despite the effect on vigorous exercise being negative when using both fixed effects and 2SLS separately, when combining the two, it gives a highly significant positive outcome. From these estimates, it would seem that one's subjective feeling of health, as well as their independence when performing physical tasks in the home, are improved due to an increase in physical activity which was made possible from retirement. It may also be noteworthy before proceeding to point out the low R-squared values. Low R-square values are not uncommon and not necessarily problematic in these types of studies. There are many factors which capture changes health and choices surrounding health, which are not possible to identify and capture when performing analysis such as this. Value of that size are therefore somewhat to be expected.

Table 5. FE-2SLS - Retirement effect on health and health-related behaviour

	(1) Hospital nights	(2) Activities of daily living	(3) Self-rated health	(4) Body Mass Index	(5) Chronic illnesses	(6) Fruit and vegetables	(7) Smoking	(8) Drinking	(9) Moderate exercise	(10) Vigorous exercise
Retirement	-0.285	-0.119***	0.0783***	0.0899	0.0700	-0.00680	-0.0257	0.0484*	0.0869***	0.0641***
	(0.255)	(0.0183)	(0.0173)	(0.0767)	(0.0684)	(0.0143)	(0.0160)	(0.0290)	(0.0147)	(0.0230)
Age	-0.0953	-0.165***	0.00816	0.327***	0.00831	0.00514	-0.0222***	0.0355***	0.0599***	0.0444***
	(0.119)	(0.00948)	(0.00664)	(0.0330)	(0.0269)	(0.00469)	(0.00508)	(0.0109)	(0.00578)	(0.00797)
Age^2	0.00317***	0.00108***	3.01e-05	-0.00291***	7.67e-05	-9.85e-06	7.13e-05***	-0.000179***	-0.000481***	-0.000301***
	(0.000363)	(4.10e-05)	(2.48e-05)	(0.000126)	(9.77e-05)	(2.36e-05)	(2.18e-05)	(4.05e-05)	(2.31e-05)	(3.14e-05)
Partner	-0.0556	-0.00668*	0.00252	0.00310	-0.355***	-0.00122	-0.0186***	-0.00589*	0.00226	-0.00300
	(0.0516)	(0.00396)	(0.00267)	(0.0128)	(0.0119)	(0.00144)	(0.00149)	(0.00320)	(0.00197)	(0.00247)
Wave dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Constant	-4.792	6.009***	-0.203	17.23***	1.119	0.655***	1.293***	-1.142*	-0.968***	-0.989**
	(6.587)	(0.505)	(0.352)	(1.744)	(1.437)	(0.248)	(0.262)	(0.603)	(0.308)	(0.424)
First stage F-score	1327.03	1327.03	1327.03	1327.03	1327.03	420.42	766.81	553.47	1036.52	1036.52
Observations	140,994	140,994	140,994	140,994	140,994	88,637	83,622	75,142	119,234	119,234
Number of id	43,771	43,771	43,771	43,771	43,771	40,797	36,468	41,496	44,217	44,217
R-squared	0.0035	0.0068	0.0349	0.0043	0.0035	0.0006	0.0329	0.0014	0.0309	0.0203

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6.2. Heterogeneity Analysis

Due to the diversity of the sample, it is to be expected that there could be non-uniform effects of retirement dependent on different demographic factors. In order to have a better understanding of the impact of retirement, we will re-run FE-2SLS regressions based on level of education and gender, to establish if some results were either led or dampened by certain demographic groups.

6.2.1. ISCED

Hospital nights and chronic illnesses remain relatively similar regardless of education level and stay statistically insignificant, ADL improves more for the lowly educated than highly educated, and self-rated health improves slightly more for the highly educated. Both retirement remains significant for both dependent variables. Interestingly enough, BMI goes in opposite directions depending on education level, with the more educated losing weight, and the less educated gaining weight, and both estimates turning significant at the 5 per cent level. Since the estimate for the full sample is insignificant and small in magnitude, this seems to be an example of the importance of studying the potential heterogeneous estimates, so not to miss true effects. In this case it could be that lower educated people have more physical jobs, and thus retirement causing a more sedentary lifestyle.

In terms of habits, consumption of greens remains small in magnitude and insignificant, the size of estimate for alcohol remains relatively unchanged, but loses its marginal significance. Moderate exercise remains highly significant, although the probability for frequently exercising is higher for highly educated people, standing at 11.1 percentage points compared to the lower educated's 6.77. Furthermore, the people with lower education levels see a small increase in probability of vigorous exercise of 1.58 points (and insignificant), while the highly educated have a significant 15.9 percentage point higher probability of doing vigorous exercise. The lower educated also see a 4.57 percentage point reduction in probability of smoking, twice that of the full sample, and significant at the 5 per cent level, while the impact on smoking for higher educated individuals seems to be inconsequential. This could be explained by the fact that more highly educated people on average smoked less then the lower educated to begin with.

Table 6. FE-IV Health by ISCED

	Hospital nights		**Activities of daily living**		**Self-rated health**		**Body mass index**		**Chronic illnesses**	
	Low	High	Low	High	Low	High	Low	High	Low	High
Retirement	-0.354	-0.0312	-0.122***	-0.0741***	0.0715***	0.101***	0.259**	-0.228**	0.0744	0.0664
	(0.323)	(0.419)	(0.0239)	(0.0280)	(0.0218)	(0.0287)	(0.102)	(0.110)	(0.0873)	(0.111)
Age	-0.0694	-0.120	-0.185***	-0.101***	0.00701	0.0153	0.277***	0.431***	0.0135	0.00247
	(0.148)	(0.190)	(0.0119)	(0.0141)	(0.00788)	(0.0126)	(0.0408)	(0.0548)	(0.0321)	(0.0504)
Age^2	0.00339***	0.00197***	0.00118***	0.000675***	5.05e-05*	-8.85e-05*	-0.00273***	-0.00321***	5.86e-05	5.31e-05
	(0.000457)	(0.000593)	(5.03e-05)	(6.68e-05)	(3.04e-05)	(4.55e-05)	(0.000159)	(0.000210)	(0.000120)	(0.000176)
Partner	-0.0201	-0.151*	-0.00679	-0.00569	0.00313	0.00142	-0.00793	0.0329*	-0.359***	-0.343***
	(0.0631)	(0.0857)	(0.00502)	(0.00545)	(0.00306)	(0.00543)	(0.0159)	(0.0197)	(0.0140)	(0.0228)
Wave dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Constant	-7.448	1.342	6.877***	3.556***	-0.271	-0.0485	19.79***	11.35***	0.849	1.597
	(8.301)	(10.24)	(0.646)	(0.712)	(0.419)	(0.653)	(2.181)	(2.769)	(1.722)	(2.619)
First stage F-score	852.21	488.42	852.21	488.42	852.21	488.42	852.21	488.42	852.21	488.42
Observations	103,386	37,608	103,386	37,608	103,386	37,608	103,386	37,608	103,386	37,608
Number of id	32,473	11,355	32,473	11,355	32,473	11,355	32,473	11,355	32,473	11,355
R-squared	0.0101	0.0064	0.0083	0.0045	0.0307	0.0117	0.0070	0.0069	0.0030	0.0064

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7. FE-IV Behaviour and habits by ISCED

	Fruit and vegetables		**Smoking**		**Drinking**		**Moderate exercise**		**Vigorous exercise**	
	Low	High	Low	High	Low	High	Low	High	Low	High
Retirement	0.000615	-0.0150	-0.0454**	0.0113	0.0488	0.0523	0.0679***	0.111***	0.0158	0.159***
	(0.0194)	(0.0195)	(0.0205)	(0.0252)	(0.0359)	(0.0497)	(0.0193)	(0.0220)	(0.0293)	(0.0367)
Age	0.00440	0.00955	-0.0215***	-0.0220**	0.0287**	0.0578***	0.0675***	0.0366***	0.0429***	0.0490***
	(0.00588)	(0.00764)	(0.00609)	(0.00954)	(0.0131)	(0.0202)	(0.00708)	(0.00984)	(0.00945)	(0.0152)
Age^2	-6.09e-06	-4.25e-05	5.75e-05**	0.000103***	-0.000146***	-0.000281***	-0.000531***	-0.000303***	-0.000303***	-0.000285***
	(2.97e-05)	(3.90e-05)	(2.73e-05)	(3.77e-05)	(4.81e-05)	(7.92e-05)	(2.85e-05)	(4.15e-05)	(3.78e-05)	(6.02e-05)
Partner	-0.000956	-0.00353	0.00492***	0.00340	-0.00644*	-0.00425	0.00307	-7.54e-05	-0.00101	-0.00917*
	(0.00166)	(0.00270)	(0.00170)	(0.00312)	(0.00366)	(0.00661)	(0.00230)	(0.00357)	(0.00275)	(0.00558)
Wave dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
First stage F-score	257.96	155.80	495.50	273.71	352.04	197.44	661.49	378.20	661.49	378.20
Observations	65,142	23,495	62,862	19,236	55,906	19,236	88,597	30,637	88,597	30,637
Number of id	30,168	10,654	27,493	10,593	30,928	10,593	32,966	11,305	32,966	11,305
R-squared	0.0018	0.0000	0.0447	0.0116	0.0019	0.0083	0.0315	0.0051	0.0019	0.0229

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6.2.2. Gender

Hospital nights and chronic illnesses stay insignificant across genders and very similar in magnitude, and also similar to the full sample. It does not seem probable that retirement has any effect on either of these variables. ADL and self-rated health stay significant for both genders, however with some impact size differences. While the signs of the estimates stay the same, with self-rated health being rated higher after retirement and the total number of ADLs decreasing, men benefit more in terms of ADL, decreasing by 1.45 vs 0.097, while women rate their health higher, 9.05 percentage points vs 6.77 percentage points. Moreover, an increase in BMI is significant for women at the 5 per cent level while inignificant for men, and the increase also being substantially larger for women.

As seen before, the probability of more regularly eating fruits and vegetables after retirement remains small in impact and statistically insignificant. While the probability of smoking still goes down due to retirement, the effect is slightly higher for women than men, 2.95 and 1.58 points respectively, although still insignificant. For men the probability of regular alcohol consumption remains at the same significance level as the full sample (at the 10 per cent level), while insignificant for women. The probability of drinking is much larger for men, 9.51 compared to 1.28 percentage points for women, with the full sample landing somewhere in the middle at 4.84 points. It seems pretty clear that the effect on drinking (although not particularly significant) is driven by men's habits. In terms of exercise, the results are fairly similar across the board. Moderate exercise stays at the same significance level for both men and women separately, as well as the full sample, and with small differences in the size of the effect (8.48, 8.64, and 8.68 percentage points respectively). The big difference shows up in vigorous exercise, where for women the change stays significant at the 1 per cent level, while for men it is not even significant at the 10 per cent level. The estimate for the full sample lands in the middle of the two separate groups at 6.42 points. It is curious then that BMI sees a significant increase for women, despite their significantly greater participation in exercise compared to men.

Table 8. FE-2SLS Retierment effect on health by gender

	Hospital nights		Activities of daily living		Self-rated health		Body mass index		Chronic illnesses	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Retirement	-0.347	-0.343	-0.145***	-0.0972***	0.0677**	0.0905***	0.0243	0.193**	0.0106	0.108
	(0.419)	(0.321)	(0.0316)	(0.0211)	(0.0289)	(0.0211)	(0.123)	(0.0972)	(0.112)	(0.0854)
Age	-0.0428	-0.126	-0.164***	-0.165***	0.0111	0.00508	0.289***	0.356***	0.00218	0.0186
	(0.177)	(0.158)	(0.0143)	(0.0127)	(0.0101)	(0.00900)	(0.0466)	(0.0478)	(0.0396)	(0.0375)
Age^2	0.00325***	0.00290***	0.00113***	0.00102***	4.85e-06	5.54e-05*	-0.00278***	-0.00297***	5.81e-05	6.04e-05
	(0.000601)	(0.000456)	(6.45e-05)	(5.42e-05)	(4.25e-05)	(3.04e-05)	(0.000193)	(0.000171)	(0.000162)	(0.000123)
Partner	0.0168	-0.0639	0.000854	-0.00980*	-0.000708	0.00182	0.00137	0.0108	0.101***	-0.339***
	(0.0176)	(0.0692)	(0.00130)	(0.00559)	(0.000876)	(0.00375)	(0.00385)	(0.0194)	(0.00390)	(0.0170)
Wave dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Constant	-8.542	-1.696	5.800***	6.219***	-0.286	-0.111	19.56***	15.13***	1.069	0.582
	(9.853)	(8.689)	(0.750)	(0.680)	(0.517)	(0.485)	(2.409)	(2.561)	(2.050)	(2.035)
First stage F-score	692.58	661.57	692.58	661.57	692.58	661.57	692.58	661.57	692.58	661.57
Observations	72,368	68,628	72,368	68,628	72,368	68,628	72,368	68,628	72,368	68,628
Number of id	22,233	21,538	22,233	21,538	22,233	21,538	22,233	21,538	22,233	21,538
R-squared	0.0075	0.0015	0.0006	0.0181	0.0264	0.0443	0.0098	0.0037	0.0075	0.0015

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9. FE-2SLS Retirement effect on health-related behaviour by gender

	Fruit and vegetables		Smoking		Drinking		Moderate exercise		Vigorous exercise	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Retirement	-0.00409	-0.0115	-0.0158	-0.0295*	0.0951*	0.0128	0.0850***	0.0864***	0.0559	0.0765***
	(0.0262)	(0.0139)	(0.0285)	(0.0179)	(0.0517)	(0.0327)	(0.0246)	(0.0178)	(0.0377)	(0.0287)
Age	0.00444	0.00656	-0.0180**	-0.0291***	0.0414**	0.0270*	0.0655***	0.0553***	0.0475***	0.0404***
	(0.00808)	(0.00525)	(0.00838)	(0.00622)	(0.0174)	(0.0141)	(0.00856)	(0.00800)	(0.0116)	(0.0113)
Age^2	-1.94e-05	-6.59e-06	8.55e-05**	6.94e-05***	-0.000269***	-7.03e-05	-0.000506***	-0.000462***	-0.000313***	-0.000282***
	(4.18e-05)	(2.70e-05)	(3.97e-05)	(2.52e-05)	(7.20e-05)	(4.77e-05)	(3.74e-05)	(2.99e-05)	(5.16e-05)	(3.99e-05)
Partner	-0.00343	0.000541	0.00462*	0.00410**	0.00659	-0.0156***	0.00347	0.00147	-0.00243	-0.00412
	(0.00252)	(0.00168)	(0.00241)	(0.00189)	(0.00540)	(0.00387)	(0.00284)	(0.00270)	(0.00380)	(0.00326)
Wave dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Constant	0.723*	0.570**	1.001**	1.692***	-1.094	-1.097	-1.215***	-0.767*	-1.103*	-0.855
	(0.415)	(0.283)	(0.414)	(0.328)	(0.928)	(0.787)	(0.444)	(0.432)	(0.597)	(0.609)
First stage F-score	214.56	208.93	399.03	385.07	280.07	284.98	541.19	515.55	541.19	515.55
Observations	44,975	43,662	43,671	39,951	38,633	36,509	61,238	57,996	61,238	57,996
Number of id	20,579	20,218	18,975	17,493	21,150	20,346	22,442	21,775	22,442	21,775
R-squared	0.0060	0.0001	0.0303	0.0384	0.0022	0.0000	0.0157	0.0515	0.0233	0.0202

Clustered standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

7. Robustness Tests

A number of tests will be applied in order to test the validity of the yielded estimates. Firstly, it is done to check for potential outliers and their potential influence, in order to reject the possibility that specific subgroups are causing the results. Secondly, to test the model validity, by including additional variables to see if the effect attributed to retirement may in fact have been due to omitted variables. Thirdly, by checking how sensitive the dependent variables are to how they are specified.

The first major concern about these results so far is that the results may be driven by retirement effects of a specific country, or similarly, that results may be biased by anticipatory behaviour from stepwise increases in retirement age. In order to test for this, the regressions were re-run for each dependent variable of interest excluding one country at a time. A summary of the retirement estimates for each excluded country is presented in table 9. The same FE-2SLS regression is run with the same age and partner variables and wave dummies, although the estimates for those variables are excluded from the table. There are some small changes from a handful of the countries, although much also stays the same. None of the variables change signs from any excluded country, and with the exception of vigorous exercise when Spain is excluded, no previously estimated significant effect from retirement turns insignificant. The steady significant estimates stay at a similar size, with a difference at around 1 percentage point give or take from the original estimate. Differences in estimates are more noticeable for variables that vary in significance levels, which in this paper turns out to be smoking and drinking. Smoking becomes significant at the 10 per cent level when excluding Germany and France, and at the 5 per cent level when excluding Spain. For drinking, the exclusion of four countries lead to a 10 per cent significance level (Austria, Spain, Italy, and Switzerland), and the exclusion of one country (Belgium) a 5 per cent significance level. The estimates of greatest effect for these two variables also turn out to be the significant ones from the excluded countries, such that people are less likely to smoke and more likely to frequently drink. This would indicate that these countries suppress the estimates, with Austria, France, and Germany being less likely to stop smoking, and Austria, Spain, Italy, Switzerland, and Belgium being less inclined to frequent drinking. This country-based heterogeneity could be important to take into account when considering future retirement-related policies. However, it does not seem like a singular country was leading the results in any of the health and behaviour indicators in a very substantial way.

Table 10. FE-2SLS results from excluding countries

Excluded country	(1) Hospital nights	(2) Activities of daily living	(3) Self-rated health	(4) Body mass index	(5) Chronic illnesses	(6) Fruit and vegetables	(7) Smoking	(8) Drinking	(9) Moderate exercise	(10) Vigorous exercise
Austria	-0.289	-0.118***	0.0672***	0.0771	0.0582	-0.00664	-0.0187	0.0508*	0.0916***	0.0658***
	(0.243)	(0.0179)	(0.0173)	(0.0756)	(0.0688)	(0.0130)	(0.0156)	(0.0285)	(0.0143)	(0.0227)
Germany	-0.225	-0.103***	0.0751***	0.0861	0.103	-0.00555	-0.0271*	0.0430	0.0891***	0.0771***
	(0.252)	(0.0189)	(0.0181)	(0.0801)	(0.0713)	(0.0154)	(0.0161)	(0.0287)	(0.0152)	(0.0237)
Sweden	-0.295	-0.139***	0.0867***	0.148	0.0580	-0.00624	-0.0327	0.0247	0.102***	0.0516*
	(0.325)	(0.0221)	(0.0208)	(0.0937)	(0.0814)	(0.0160)	(0.0205)	(0.0374)	(0.0187)	(0.0283)
Netherlands	-0.359	-0.126***	0.0855***	0.0997	0.0881	-0.00803	-0.0258	0.0494	0.0891***	0.0737***
	(0.264)	(0.0189)	(0.0178)	(0.0793)	(0.0703)	(0.0147)	(0.0172)	(0.0307)	(0.0154)	(0.0240)
Spain	-0.194	-0.110***	0.0763***	0.103	0.0866	-0.00855	-0.0408**	0.0581*	0.0753***	0.0533**
	(0.272)	(0.0190)	(0.0182)	(0.0785)	(0.0724)	(0.0151)	(0.0163)	(0.0300)	(0.0153)	(0.0241)
Italy	-0.313	-0.107***	0.0813***	0.0449	0.0815	-0.0108	-0.0211	0.0537*	0.0815***	0.0670***
	(0.248)	(0.0178)	(0.0171)	(0.0741)	(0.0677)	(0.0143)	(0.0157)	(0.0285)	(0.0140)	(0.0227)
France	-0.290	-0.141***	0.0815***	0.129	0.0633	-0.000935	-0.0331*	0.0409	0.0901***	0.0770***
	(0.295)	(0.0213)	(0.0195)	(0.0868)	(0.0763)	(0.0165)	(0.0186)	(0.0336)	(0.0166)	(0.0262)
Denmark	-0.320	-0.113***	0.0773***	0.0792	0.0771	-0.00786	-0.0117	0.0435	0.0893***	0.0489**
	(0.277)	(0.0195)	(0.0182)	(0.0821)	(0.0725)	(0.0145)	(0.0166)	(0.0305)	(0.0160)	(0.0244)
Switzrland	-0.330	-0.124***	0.0817***	0.0585	0.0596	-0.0106	-0.0232	0.0573*	0.0931***	0.0675***
	(0.283)	(0.0205)	(0.0188)	(0.0855)	(0.0749)	(0.0167)	(0.0173)	(0.0322)	(0.0160)	(0.0252)
Belgium	-0.225	-0.112***	0.0738***	0.0828	0.0206	-0.00316	-0.0257	0.0552**	0.0705***	0.0564**
	(0.240)	(0.0177)	(0.0169)	(0.0759)	(0.0676)	(0.0147)	(0.0158)	(0.0276)	(0.0143)	(0.0225)

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In addition to a country leading the estimates, we may also be concerned that our results are primarily driven by not adequately estimating the age effect. Two additional tests are therefore performed, the first one additional age variables were added, age to the power of 3 and to the power of 4. The results from this are presented in table 10. Secondly, one might worry that the model does not control for time trends specific to the inhabiting country. If there are non-linear relationships between our variables of interest and country-specific retirement age, the true effect might not be estimated (Godard, 2016). A way to test for this is to introduce interaction between age variables country dummies.

The additional age variables diminish the size and significance of several of our estimates, with only self-rated health and vigorous exercise remaining statistically significant, and ADL and moderate exercise losing much of the size of their impact. The age and country interaction variables on the other hand do not lead to such drastic changes. Retirement remains significant for all the same health and behaviour indicators, with the addition of alcohol consumption becoming significant at the 5 per cent level. The size of the effect of retirement remains relatively the same, with the probability of exercising decreasing slightly and the probability of drinking increasing slightly. So while the estimates are relatively stable to various country-related tests, there might be unexplored age-related issues to look at when it comes to conducting similar work and analysing these results.

Additionally, the regressions performed on health indicators used all available waves in order to get as accurate and updated estimates as possible, while behaviour indicators were only measured for waves they were available, and it was assumed that these different timespans were somewhat identical and could be discussed and compared. In order to check if this were the case, new regressions were rerun on each health indicator on the waves used by each behaviour indicator. This did not lead to any significant changes in estimates so to save space these results are not presented in this chapter, but the corresponding tables can be found in the appendix.

Table 11. FE-2SLS with additional age variables

VARIABLES	(1) Hospital nights	(2) Acvitivies of dialy living	(3) Self-rated health	(4) Body Mass Index	(5) Chronic illnesses	(6) Fruit and vegetables	(7) Smoking	(8) Drinking	(9) Moderate exercise	(10) Vigorous exercise
Retirement	-0.116	0.00660	0.0840***	-0.00768	0.0865	-0.00510	-0.0141	0.0408	0.0183	0.0632**
	(0.318)	(0.0226)	(0.0215)	(0.0952)	(0.0859)	(0.0163)	(0.0190)	(0.0336)	(0.0175)	(0.0274)
Age	2.240	-0.475***	0.105	-0.135	0.150	0.0302	0.121	-0.241	-0.163*	0.114
	(1.367)	(0.161)	(0.103)	(0.532)	(0.421)	(0.0975)	(0.0805)	(0.204)	(0.0968)	(0.129)
Age^2	-0.0482	0.0122***	-0.00213	0.00539	-0.00285	-0.000785	-0.00291	0.00584	0.00330	-0.00169
	(0.0309)	(0.00378)	(0.00228)	(0.0118)	(0.00935)	(0.00214)	(0.00179)	(0.00450)	(0.00217)	(0.00285)
Age^3	0.000494	-0.000151***	2.11e-05	-6.07e-05	2.63e-05	9.25e-06	2.78e-05	-5.83e-05	-2.42e-05	1.23e-05
	(0.000306)	(3.86e-05)	(2.20e-05)	(0.000115)	(9.06e-05)	(2.06e-05)	(1.73e-05)	(4.35e-05)	(2.14e-05)	(2.75e-05)
Age^4	-1.74e-06	6.97e-07***	-7.60e-08	1.44e-07	-8.59e-08	-3.93e-08	-9.53e-08	2.07e-07	3.94e-08	-4.04e-08
	(1.12e-06)	(1.46e-07)	(7.83e-08)	(4.10e-07)	(3.23e-07)	(7.33e-08)	(6.14e-08)	(1.55e-07)	(7.77e-08)	(9.77e-08)
Partner	-0.0550	-0.00654*	0.00254	0.00288	-0.355***	-0.00145	0.00474***	-0.00788**	0.00195	-0.00205
	(0.0516)	(0.00394)	(0.00268)	(0.0128)	(0.0119)	(0.00157)	(0.00163)	(0.00344)	(0.00211)	(0.00266)
Wave dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Constant	-43.88*	8.059***	-1.793	26.32***	-1.377	0.451	-1.349	3.691	3.549**	-2.300
	(23.01)	(2.576)	(1.739)	(8.976)	(7.090)	(1.652)	(1.356)	(3.446)	(1.619)	(2.207)
Observations	140,994	140,994	140,994	140,994	140,994	77,094	72,418	65,604	103,400	103,400
Number of id	43,771	43,771	43,771	43,771	43,771	35,528	31,780	36,402	38,412	38,412
R-squared	0.0110	0.0011	0.0353	0.0039	0.0034	0.0006	0.0332	0.0014	0.0462	0.0219

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12. FE-2SLS with age and country interaction variables

VARIABLES	(1) Hospital nights	(2) Activities of daily living	(3) Self-rated health	(4) Body Mass Index	(5) Chronic illnesses	(6) Fruit and vegetables	(7) Smoking	(8) Drinking	(9) Moderate exercise	(10) Vigorous exercise
Retirement	-0.318	-0.119***	0.0804***	0.0892	0.0659	-0.00743	-0.0259	0.0487*	0.0698***	0.0541**
	(0.254)	(0.0182)	(0.0173)	(0.0768)	(0.0684)	(0.0147)	(0.0159)	(0.0290)	(0.0143)	(0.0225)
Age	0.131	-0.182***	0.00151	0.291***	-0.000437	0.0196**	-0.0185**	0.0380***	0.0670***	0.0545***
	(0.133)	(0.0109)	(0.00726)	(0.0369)	(0.0295)	(0.00805)	(0.00756)	(0.0147)	(0.00801)	(0.0109)
Age^2	-0.000306	0.00131***	0.000145***	-0.00244***	0.000149	-8.84e-05	7.08e-05*	-0.000238***	-0.000523***	-0.000370***
	(0.00107)	(9.76e-05)	(5.33e-05)	(0.000295)	(0.000210)	(5.52e-05)	(4.13e-05)	(8.01e-05)	(4.45e-05)	(5.81e-05)
Age×Country	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Age^2×Country	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Partner	-0.0557	-0.00668*	0.00252	0.00310	-0.355***	-0.00134	0.00475***	-0.00790**	0.00189	-0.00205
	(0.0516)	(0.00396)	(0.00267)	(0.0128)	(0.0119)	(0.00157)	(0.00163)	(0.00344)	(0.00212)	(0.00265)
Wave dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Constant	-8.130	6.484***	-0.199	18.26***	1.707	0.622**	1.060***	-0.881	-1.124***	-1.020**
	(6.789)	(0.512)	(0.357)	(1.754)	(1.470)	(0.257)	(0.312)	(0.631)	(0.346)	(0.478)
First stage F-score	1088.43	1088.43	1088.43	1088.43	1088.43	315.93	596.74	683.72	829.88	829.88
Observations	140,994	140,994	140,994	140,994	140,994	77,094	72,418	65,604	103,400	103,400
Number of id	43,771	43,771	43,771	43,771	43,771	35,528	31,780	36,402	38,412	38,412
R-squared	0.0107	0.0115	0.0109	0.0015	0.0056	0.0048	0.0326	0.0037	0.0174	0.0033

Clustered standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Finally, we also tested how sensitive the estimates where to different specifications of the binary dependent variables. The variables were redefined as follows: self-rated health took the value 1 when the answer “very bad” was given, and 0 otherwise. Fruit and vegetable consumption took the value 1 if the individual reported to eating greens less than once a month, and 0 otherwise. Smoking took the value of 1 if the individual did not currently smoke, and 0 otherwise. The drinking variable took the value of 1 if the individual had not had a drink at all in the last 3 months, and 0 otherwise. Moderate and vigorous exercise took the value 1 if the individual reported to “hardly ever, or never” participate in corresponding activities, and 0 otherwise.

Table 13. FE-2SLS with re-specified binary dependent variables

VARIABLES	(1) Self-rated health	(1) Fruit and vegetable	(2) Smoking	(3) Drinking	(4) Moderate exercise	(5) Vigorous exercise
Retirement	-0.0207***	0.00289	0.0186	0.0103	-0.0772***	-0.0768***
	(0.00761)	(0.0101)	(0.0186)	(0.0212)	(0.0114)	(0.0221)
Age	-0.0176***	-0.00264	0.0239***	-0.0231**	-0.0540***	-0.0509***
	(0.00345)	(0.00292)	(0.00577)	(0.00945)	(0.00484)	(0.00773)
Age^2	0.000221***	2.01e-05	-0.000108***	0.000238***	0.000448***	0.000385***
	(1.27e-05)	(1.54e-05)	(2.63e-05)	(3.44e-05)	(1.95e-05)	(3.03e-05)
Partner	0.00613	0.000467	0.0169**	-0.0235*	0.0138*	0.00998
	(0.00521)	(0.00381)	(0.00853)	(0.0135)	(0.00760)	(0.0113)
Wave dummies	✓	✓	✓	✓	✓	✓
Constant	0.273	0.105	-0.289	0.706	1.666***	1.987***
	(0.188)	(0.155)	(0.292)	(0.525)	(0.257)	(0.412)
Observations	140,994	88,637	83,622	75,142	119,234	119,234
Number of id	43,771	40,797	36,468	41,496	44,217	44,217

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

If any major differences occurred from these changes it might have led to suspucison of misspecification when performing the empirical analysis. In this case however, the effect seems stable. Significance levels remain, and impact is of similar size although of the opposite sign which follows the change in how the variables were specified. The impact of self-rated health is smaller, but that is not surprising as the initial specification included two answers for rating health, whereas this only included one.

8. Discussion

The results here using FE-2SLS agree with previous work (Coe and Lindeboom, 2008; Coe and Zamarro, 2011; Gorry et al., 2018; Johnston and Lee, 2009) that retirement has a positive and significant effect on more subjective variables such as self-rated health and activities of daily living, while more objective variables such as body mass index, hospitalisation, and chronic illnesses remain insignificant for the main sample. However, it is possible that variables such as hospitalisation and chronic illnesses have a stronger effect in the long run, which may not have been captured by these regressions. Lucifora and Vigani (2018) for example found that healthcare utilisation unfolded more in the long-term after retirement. BMI on the other hand, which at times was found to be significant when controlling for demographics, might be more reactive in the short term.

In terms of health-related behaviour, the results in this paper differed slightly from previous work. Here it was only found that moderate and vigorous exercise were significantly (and positively) affected by retirement, while and Kesavayuth et al. (2018) found significant changes in additional behaviours such as drinking, smoking, healthcare utilisation. In terms of heterogeneity, the significance levels and direction of effects are similar to those of Celidoni and Rebba (2016), with the effect on drinking for men being more significant for men than women, same significance level for moderate exercise for men and women, but a higher significance level for women in terms of vigorous exercise. When looking at education levels, the impact was greater and more significant for higher educated than lower educated. If we assume some level of correlation between level od education and degree of physically demanding job, these results are consistent with Kesavayuth et al. (2018), who found impact on exercise to be positive and significant for those who did not work in a physically demanding job, but insignificant results for those who did. There was also a significant decrease in probability of smoking among the lower educated sample, which was not present for the the higher educated sample, this could be that the higher educated people already had a lower prevalence of smoking.

When considering the different empirical approaches, there seem to be advantages to using alternatives to regular OLS. OLS estimates overwhelmingly suggested that retirement has a negative effect on both health and habit, which was expected as individuals of already poor health are likely more inclined to retire early. In the model Grossman model with endogenous retirement constructed by Galama et al. (2013), a mechanism through which this happens is that people of higher human capital invests more in health and retire later, while those with lower human capital invest less in their health which then deteriorates, forcing them to retire earlier. This unaccounted for endogeneity could then be the cause for the detrimental OLS estimates. When considering fixed effects the results were a bit less clear. The only significant and marginally significant results were for ADL and self-rated health, which indicated a positive impact of retirement, there were also some marginally significant results such as a decrease in smoking and increase in exercise, as well as a significant increase in drinking. The use of an instrumental variable curiously enough provides estimates close to OLS in terms of health, with mixed signs for health-related behaviour. The negative impact on self-rated health is especially unexepected and divergent from previous work, in addition to the significant detrimental effect on objective health indicators. It is unclear why these differences are present. It could be that true effects are unveiled, the difference in sample and time period, that one of the IV assumptions has been violated, or perhaps a difference in instrument. While referenced literature has all focused on exogenous variation in pension ages, there has been some subtle differences. While this paper solely considered ordinary retirement age, others have also utilised early retirement age, private pensions, and temporary early retirement offers, which may have been the cause of divergence in estimates.

FE-2SLS was primarily used in this study due to its ability do account for endogeneity, and its more consistent results with previous work, however, there is no one industry standard used when studying retirement and health issues. What the preliminary results in this paper showed is how sensitive the results will be to different model specifications, which should be taken into account when choosing an econometric model.

As with a lot of survey data, a problem in data collection is attrition. This is not necessarily an issue, as long as the reason for not participating in the survey is random and not related to the studied variables, if it is not random however, the results would suffer from selection bias. This was not specifically dealt with in this paper, but other articles used inverse probability weighting (Godard, 2016; Lucifora and Vigani, 2018) or compared balanced and unbalanced panels (Godard, 2016; Kesavayuth et al., 2018) and did not detect signs of selection bias. The extent of possible selection bias should also have been limited by the use of fixed effects if the attrition is connected time-invariant factors (Kesavayuth et al., 2018; Lucifora and Vigani, 2018).

One of the main interests of this paper was to try and establish a link starting with retirement causing changes in behaviour and habits, which then leads to changes in health, as the Grossman model predicts that people invest in their health through healthy habits. The possibility of establishing this connection was limited, as it is also assumed that retirement is endogenous to the associated mechanisms, making it complicated to involve both retirement and behaviour as explanatory variables when estimating health. The compromise here was to present estimates for both sets of measures separately, and then see if connections could be drawn from changes in behaviour to changes in health. It was found that people were more likely to rate their health as at least very good, and it also decreased issues with activities of daily living (ADL). These results were not sensitive to the countries included in the sample, but retirement had different effects on the sample depending on education and gender. Health behaviour was more sensitive, with probability of smoking and drinking being significant depending on countries included in the sample, and vigorous exercise being sensitive to education and gender. It then seems like that subjctive feelings about health and indepence in daily activities are at least partially driven by investing in the free time from retirement into various activities of exercise, and for some parts of the population stop smoking. Takeaways for policymakers who want to increase the retirement age would then be to look into ways of encouraging exercise the years before retirement, as a possible way to preserve health. Concering the health post-retirement, we saw that people of lower education do not increase vigorous exercise, while also seeing a rise in BMI. Encouragement may be needed to to engage this sub-group in appropriate physical activities. From the robustness checks it was also made clear that individuals from certain countries were inclined to increase their alcohol consumption when entering retirement. This may be an additional avenue to improve health post-retirement.

9. Concluding Remarks

In this paper the effect of retirement on health and health-related behaviour was studied by applying a FE-2SLS model on several waves of the Survey of Health, Ageing, and Retirement in Europe. This model was chosen due to its ability to deal with multiple sources of endogeneity in order to combat biased estimates, although separate fixed effects and 2SLS restimates as well as OLS were also presented for robustness and transparency. This thesis thus tested the consistency of previous work studying multiple variables with a new model while also using new, relevant data, while also considering mechanisms through which health changes are implemented. Similar to previous work, the most notable difference in terms of health was found in subjective health measures and activities of daily living, and when studying health behaviour, significant results were most consistently found with moderate and vigorous exercise. It seems that retirement mostly affects mobility and life satisfaction through its positive impact on exercise.

A number of tests were performed to verify the derived results. Firstly, we looked at how different demographics react to this change in employment, namely gender and level of education. This led to different results, primarily on the impact of weight gain, and habits such as drinking, smoking, and exercising. Robustness checks were also performed to check for unaccounted age and country effects. We found that the results were somewhat sensitive to these tests, which may be further studied in the future, and especially country-specific trends should be considered when applying these results for individual countries.

While initially presenting results of all four models, we chose to proceed with FE-2SLS to its results being more consistent with previous estimates, but all four models gave remarkably different estimates. So the estimates presented should be taken with a grain of salt as we have not established the cause for these differences, and if FE-2SLS is truly the “correct model”. Future work may establish an industry standard of sorts.

The connections drawn between behaviour and health are also limited due to health-related behaviour not being included as an explanatory variable for health. This was not deemed possible as retirement was also assumed to be an endogenous variable to these habits, and in such case instruments would also have to be found for these variables. Future work may focus on finding better ways of including these mechanisms as explanations for changes in health.

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Appendix

Table 1. Waves 4, 5, and 6 to match fruit and vegetables

	(1) Hospital nights	(2) Activities of daily living	(3) Self-rated health	(4) Body Mass Index	(5) Chronic illnesses
Retirement	-0.283	-0.120***	0.0805***	0.0870	0.0708
	(0.255)	(0.0183)	(0.0173)	(0.0767)	(0.0684)
Age	-0.319***	-0.123***	-0.0202***	0.398***	-0.0144
	(0.0499)	(0.00536)	(0.00373)	(0.0183)	(0.0145)
Age^2	0.00317***	0.00107***	3.38e-05	-0.00292***	7.89e-05
	(0.000363)	(4.11e-05)	(2.48e-05)	(0.000126)	(9.77e-05)
Partner	-0.0555	-0.00669*	0.00252	0.00308	-0.355***
	(0.0516)	(0.00396)	(0.00268)	(0.0128)	(0.0119)
Wave dummies	✓	✓	✓	✓	✓
Constant	8.531***	3.573***	1.459***	13.04***	2.450***
	(1.631)	(0.170)	(0.129)	(0.627)	(0.500)
Observations	140,994	140,994	140,994	140,994	140,994
Number of id	43,771	43,771	43,771	43,771	43,771

Table 2. Waves 1, 2, 4, and 5 to match smoking

VARIABLES	(1) Hospital nights	(2) Activities of daily living	(3) Self-rated health	(4) Body Mass Index	(5) Chronic illnesses
Retirement	-0.277	-0.120***	0.0794***	0.0878	0.0707
	(0.255)	(0.0183)	(0.0173)	(0.0767)	(0.0684)
Age	-0.318***	-0.122***	-0.0200***	0.399***	-0.0152
	(0.0498)	(0.00535)	(0.00373)	(0.0183)	(0.0145)
Age^2	0.00319***	0.00107***	3.09e-05	-0.00292***	7.88e-05
	(0.000363)	(4.11e-05)	(2.48e-05)	(0.000126)	(9.78e-05)
Partner	-0.0555	-0.00670*	0.00252	0.00304	-0.355***
	(0.0516)	(0.00396)	(0.00267)	(0.0128)	(0.0119)
Wave dummies	✓	✓	✓	✓	✓
Constant	8.352***	3.516***	1.470***	12.96***	2.506***
	(1.632)	(0.170)	(0.129)	(0.628)	(0.502)
Observations	140,994	140,994	140,994	140,994	140,994
Number of id	43,771	43,771	43,771	43,771	43,771

Table 3. Waves 2, 4, and 5 to match drinking

VARIABLES	(1) Hospital nights	(2) Activities of daily living	(3) Self-rated health	(4) Body Mass Index	(5) Chronic illnesses
Retirement	-0.282	-0.121***	0.0803***	0.0879	0.0712
	(0.255)	(0.0183)	(0.0173)	(0.0767)	(0.0684)
Age	-0.321***	-0.123***	-0.0194***	0.399***	-0.0150
	(0.0498)	(0.00535)	(0.00373)	(0.0183)	(0.0145)
Age^2	0.00317***	0.00107***	3.28e-05	-0.00292***	7.97e-05
	(0.000363)	(4.11e-05)	(2.48e-05)	(0.000126)	(9.77e-05)
Partner	-0.0555	-0.00670*	0.00250	0.00304	-0.355***
	(0.0516)	(0.00396)	(0.00268)	(0.0128)	(0.0119)
Wave dummies	✓	✓	✓	✓	✓
Constant	8.652***	3.534***	1.418***	12.95***	2.480***
	(1.627)	(0.169)	(0.129)	(0.627)	(0.501)
Observations	140,994	140,994	140,994	140,994	140,994
Number of id	43,771	43,771	43,771	43,771	43,771

Table 4. Waves 1, 2, 4, 5, 6 to match with moderate and vigorous exercise

VARIABLES	(1) Hospital nights	(2) Activities of daily living	(3) Self-rated health	(4) Body Mass Index	(5) Chronic illnesses
Retirement	-0.277	-0.121***	0.0793***	0.0874	0.0708
	(0.255)	(0.0183)	(0.0173)	(0.0767)	(0.0684)
Age	-0.317***	-0.123***	-0.0204***	0.398***	-0.0149
	(0.0499)	(0.00535)	(0.00373)	(0.0183)	(0.0145)
Age^2	0.00318***	0.00107***	3.18e-05	-0.00292***	7.81e-05
	(0.000363)	(4.11e-05)	(2.48e-05)	(0.000126)	(9.78e-05)
Partner	-0.0555	-0.00669*	0.00253	0.00308	-0.355***
	(0.0516)	(0.00396)	(0.00267)	(0.0128)	(0.0119)
Wave dummies	✓	✓	✓	✓	✓
Constant	8.312***	3.534***	1.489***	13.02***	2.490***
	(1.635)	(0.170)	(0.129)	(0.628)	(0.502)
Observations	140,994	140,994	140,994	140,994	140,994
Number of id	43,771	43,771	43,771	43,771	43,771