European Sociological Review, 2019, Vol. 35, No. 3, 346–362
doi: 10.1093/esr/jcz007
Advance Access Publication Date: 26 February 2019
Original Article

Gender and Socioeconomic Inequalities in Health at Older Ages Across Different European Welfare Clusters: Evidence from SHARE Data, 2004–2015

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Submitted April 2018; revised December 2018; accepted January 2019

Abstract

This study takes a comparative approach to assess whether the association between socioeconomic status (SES) and health in later life differs by gender in a sample of individuals aged 50 and above living in nine European countries (Austria, Belgium, Denmark, France, Germany, Italy, Spain, Sweden, and Switzerland). We apply linear hybrid (between-within) regression models using panel data (50,459 observations from 13,955 respondents) from five waves of the Survey of Health, Ageing and Retirement in Europe (SHARE) between the years 2004–2015. SES measures included education, income, and wealth. A 40- item Frailty Index (FI) of accumulated deficits, an important indicator of health in older populations, was used as dependent variable. Considering between-effects estimates, our results show that the positive impact of education and wealth on health is stronger for women living in countries where the welfare arrangements are less decommodifying and defamilializing. No such interaction is found for income and for fixed-effects estimates. This study could advance the understanding of gender inequalities in health. Also, such findings can guide future policies devoted at reducing gender and socioeconomic inequalities in health in later life.

Introduction

Reducing gender inequalities in health is recognized as a crucial goal of active and healthy ageing research and policy (Foster and Walker, 2013). Against the backdrop of a steady growth in life expectancy in Europe, there has been limited improvement in terms of healthy life years at older ages, with women systematically reporting higher rates of morbidity, disability, and healthcare utilization than men, even though they live longer (Verbrugge, 1989; Case and Paxson, 2005; Read and Gorman, 2010; Crimmins, Kim, and Solé-Auró, 2011).

Health differences between women and men are the result of the combination of both biological and social factors (Bird and Rieker, 1999; Read and Gorman,

2010) and are widely recognized as attributable to differences in socioeconomic status (SES) (Verbrugge, 1989; Östlin, 2002; Read and Gorman, 2010). The interaction between gender and SES is deeply associated with health (Östlin, 2002). Socioeconomic resources—considered as 'fundamental causes' of individual health (Link and Phelan, 1995)—structure over the life course the likelihood of women's and men's differential exposure and vulnerability to disease, their access to health-related resources, as well as the differential consequences of poor health (Macintyre and Hunt, 1997; Östlin, 2002). For example, gender-specific socioeconomic disparities in terms of education, labour market participation, financial independence, and family responsibilities may contribute to widening the gender gaps in physical and mental health throughout the life span (Denton and Walters, 1999; Bird and Rieker, 2008; Rieker, Bird, and Lang, 2010; Delaruelle, Buffel, and Bracke, 2018). At the same time, the welfare state can play an important role in redistributing socioeconomic resources which are important to health, and thus contributing to lowering gender and socioeconomic inequalities in health (Esping-Andersen, 1999; Korpi, 2000; Bambra, 2007a).

Gender inequalities in health are not static across the life span and differ by specific disease outcome (Mirowsky, 1996; Read and Gorman, 2010). On the one hand, some studies have found that women's disadvantage in health tend to diminish with advancing age (McCullough and Laurenceau, 2004; Case and Deaton, 2005; Read and Gorman, 2011) up until the point at which—among adults in their 60 s and older—women report better self-reported health than men (Zajacova, Huzurbazar, and Todd, 2017). On the other hand, others have found that gender inequalities in mental health and wellbeing tend to increase as individuals age, and are highest among the oldest adults (Pinquart and Sörensen, 2001; McDonough and Strohschein, 2003). Moreover, men may be more likely to engage in more health risk behaviours than women (such as alcohol and drug use, abuse, and dependence) that adversely affect their health and risk of premature mortality (Case and Paxson, 2005; Bird and Rieker, 2008; Read and Gorman, 2010; Rieker, Bird, and Lang, 2010). Conversely, women may be more likely to suffer from nonfatal and chronic debilitating disorders (e.g. arthritis and disability) that do not necessarily result in their death but do negatively impact their wellbeing later in life (Case and Paxson, 2005; Read and Gorman, 2010). Moreover, gender inequalities in health vary considerably cross-nationally, suggesting that the gender gaps in health are affected by country-specific characteristics (Bambra *et al.*, 2009; Crimmins, Kim, and Solé-Auró, 2011; Borrell *et al.*, 2014; Delaruelle, Buffel, and Bracke, 2018; Högberg, 2018).

While the extent of gender-based health inequalities, and the social determinants underlying them, are well documented (Bird and Rieker, 2008; Rieker, Bird, and Lang, 2010), there has been little research on the extent to which the differential impact of SES on the health of women and men varies across different macro-level contexts (Östlin, 2002; Bambra *et al.*, 2009; Read and Gorman, 2010; Gkiouleka *et al.*, 2018). The knowledge gap is even greater when considering older women and men, despite their high use of healthcare services and the importance of health to support independence in later life.

Although some research has examined cross-national differences in the degree and patterning of gender inequalities in health among different socioeconomic groups (Lahelma and Arber, 1994; Rahkonen *et al.*, 2000; Lahelma *et al.*, 2002; Bambra *et al.*, 2009), the large majority of the literature has mostly been cross-sectional and focussed on the adult population as a whole. The intersections and trajectories of SES, gender, and health in later life therefore remain unclear. Furthermore, the association between SES and health by gender shows mixed results depending on the SES indicator considered, the health outcome under examination, as well as other factors (such as political, economic, social, and cultural) (Macintyre and Hunt, 1997; Östlin, 2002; Mackenbach *et al.*, 2008).

The associations between SES and health may be confounded by unobserved factors (Kröger, Pakpahan, and Hoffmann, 2015). Unobserved permanent personal characteristics (e.g. biological factors, personality traits, intellectual abilities, or childhood conditions) that differ between individuals and that may be associated with both SES and health can be one source of confounding. Fixed-effects and 'hybrid' (between-within) models have been identified as a specific way of addressing the impact of these unobserved individual factors (i.e. omitted variables) (Allison, 2009; Schunck, 2013; Bell and Jones, 2015; Bell, Fairbrother, and Jones, 2018). Additionally, the different patterning in the intersections between gender and SES depending on the health outcome analyzed points out the need to understand the complexity and multidimensionality of health in later life with a gender-sensitive approach (Macintyre, Hunt, and Sweeting, 1996; Östlin, 2002).

In middle and old ages, women have more chronic conditions, greater levels of depression, disability, and morbidity than men (Case and Paxson, 2005; Read and Gorman, 2010; Crimmins, Kim, and Solé-Auró, 2011). The accumulation of these deficits in multidimensional health domains can be measured by a 'Frailty Index' (Rockwood and Mitnitski, 2007). A Frailty Index (FI) is a count of health deficits, reflecting the proportion of potential deficits affecting a given person, and indicating the likelihood that frailty is present. This measure provides a more complete picture of older adults' overall health, and it is consistently found to be a strong predictor of adverse health outcomes, including the subsequent mortality (Fried *et al.*, 2001; Romero-Ortuno and Kenny, 2012). Moreover, frailty is an important concept for all those who plan and provide care for older adults, since it is appropriate to identify those who need geriatric interventions (Schuurmans *et al.*, 2004).

This study addresses the shortcomings of the previous literature by investigating whether the association between three different measures of SES (education, income, and wealth) and frailty after midlife (age 50 years to baseline) vary according to gender across nine European countries with different macro-level characteristics. Thereby, we combine micro and macro determinants of health, showing how multiple dimensions of socioeconomic resources are of different importance for the health of women and men living in different contexts. Most importantly, this article aims at integrating and extending the previous literature overcoming some of its methodological limitations, specifically by applying a longitudinal design, controlling for time-constant unobserved heterogeneity at the individual level, and addressing the problem of selective panel attrition. The comparative approach, the modelling of longitudinal data, and the inclusion of frailty as a health outcome represent the key contributions of this study.

Gender Inequalities in Health: Possible Underlying Mechanisms

Micro Level: Gender, SES, and Health

Research has, so far, highlighted several explanations for gender differences in health, typically referring to a set of biological, psychosocial, behavioural, and social factors that can impact the health of women and men in different ways (Verbrugge, 1989; Read and Gorman, 2010). Among them, SES is widely recognized as the most important determinant of gender differences in health (Denton and Walters, 1999; McDonough and Walters, 2001; Lahelma *et al.*, 2002; Östlin, 2002; Huisman, Kunst, and Mackenbach, 2003). The idea, underlying the fact that individuals with higher SES are more likely than their lower SES counterparts to enjoy better health, is that SES embodies an array of 'flexible resources' (Phelan, Link, and Tehranifar, 2010)—such as knowledge, money, power, or prestige—that can be used by individuals to avoid or deal with illnesses, minimizing their negative consequences on health, and to better cope with stressful life events (Link and Phelan, 1995). Hence, women's relative lower SES places greater limits on their access to health-related resources, leading to a reduction in their health (Ross and Bird, 1994; Rieker and Bird, 2000; McDonough and Walters, 2001; Östlin, 2002; Read and Gorman, 2010). The gender-specific socialization explanations are worth mentioning because the social organization of men's and women's lives and relations may affect their exposure and vulnerability to specific risks and health behaviours (e.g. excessive alcohol consumption) through differences in employment patterns, social roles or role-related activities, or to differences in their social and economic burdens (Bird and Rieker, 1999; Read and Gorman, 2011).

However, it is still unclear to what extent SES has the same differential impact on the health of women and men in later life. On the one hand, the large majority of the existing evidence is from single-country cross-sectional analyses that did not find any interactive association between gender and SES with health at older ages (Damian *et al.*, 1999; Knurowski *et al.*, 2004; Sulander *et al.*, 2009; Connolly, O'Reilly, and Rosato, 2010). The same results were found in studies based on national longitudinal studies from England (Melzer *et al.*, 2000; McMunn, Nazroo, and Breeze, 2008), Spain (Orfila *et al.*, 2006), and Sweden (Parker *et al.*, 2013). On the other hand, the association between SES and health was found to be stronger in older men than in older women in one study from Spain (Regidor *et al.*, 1999). In contrast, a stronger association between SES and health in older women was reported in one cross-sectional study from Spain (Lasheras *et al.*, 2001) and in one follow-up study from the UK (Grundy and Holt, 2000). Other studies reported mixed results depending on the SES indicator and the health outcome considered (McDonough and Walters, 2001; Grundy and Sloggett, 2003; Prus and Gee, 2003; Rueda, Artazcoz, and Navarro, 2008; Rueda and Artazcoz, 2009; Enroth *et al.*, 2013; Torres, Rizzo, and Wong, 2016).

Macro Level: Socioeconomic Context, Gender, and Health

The related question—and our focus—asks how or in what ways SES affects the health of older women and men differently across countries. A variety of comparative studies analyzing the association between SES and health across European countries showed mixed results in the interaction between SES and gender. One cross-sectional study comparing 17 Western European countries did not find any difference between genders in the association of education with self-reported health (Bambra, Netuveli, and Eikemo, 2010). Another cross-sectional, cross-national study showed no clear pattern by gender in the relationship between education and self-reported health (von dem Knesebeck, Verde, and Dragano, 2006). Similarly, cross-sectional associations between SES and self-reported health varied by gender but in different directions among the countries and European regions studied in other works (Lahelma and Arber, 1994; Rahkonen *et al.*, 2000; Lahelma *et al.*, 2002; Dalstra *et al.*, 2006; Huijts, Eikemo, and Skalická, 2010; Rueda, 2012). The same cross-sectional fluctuations in gender and SES interactions depending on country were also reported in a study of 11 European countries (Huisman, Kunst, and Mackenbach, 2003) and in one using data from 13 European countries (Bambra *et al.*, 2009).

One of the theories that has been suggested to explain the differential gender gap in health across countries is the 'constrained choice' theory (Bird and Rieker, 2008). According to it, the differences in health between women and men can be due to macro-level opportunities and constraints that directly and indirectly shape health-related individual priorities and choices. This suggests that the systematic differences in health conditions between women and men across countries may be explained by the interaction between the state, the market, and the family in welfare provision (Esping-Andersen, 1990). The role of the welfare state is important to population health and gender equality in health in terms of how the state interacts with the family (DiPrete, 2002), and thereby reducing the specific welfare burden on women (Esping-Andersen, 1999; Korpi, 2000; Bambra, 2007a). Women's SES is related to the extent to which the welfare state facilitates female autonomy and economic independence from the family (Orloff, 1996; Bambra, 2007a).

Useful here is to combine gender stratification concepts, specifically defamilization, with others like the decommodification of labour and healthcare. Defamilization refers to the extent to which the welfare state permits individual entitlements to a socially acceptable standard of living independent of family relationships (Esping-Andersen, 1999; Korpi, 2000; Bambra, 2004, 2007a). In contrast, decommodification refers to the degree to which the welfare state frees individuals from market dependence for a socially acceptable standard of living (Esping-Andersen, 1990; Bambra, 2005a,b, 2007b). While high levels of defamilization (and decommodification) are characteristic in Northern European countries, women in Southern European countries are strongly dependent on family. Consequently, we would expect lower gender gap in health in social democratic welfare states and higher gender gap in health in familistic ones (Borrell *et al.*, 2014; Romero-Ortuno, Fouweather, and Jagger, 2014).

Therefore, this study will analyse the association between SES and health after midlife, and the extent to which this varies by gender in different European contexts. This is done in a set of three European welfare clusters, that is Northern Europe (Denmark and Sweden), Western Europe (Austria, Belgium, France, Germany, and Switzerland), and Southern Europe (Italy and Spain). We classified the nine European countries into these three generic welfare clusters because they roughly represent different geographical regions and welfare state regimes, and because this operationalization is also consistent with various social theories. Comparisons of health inequalities are based on the FI (Romero-Ortuno and Kenny, 2012) and made across three structural variables (educational level, income, and wealth) suitable to investigate the SES of older adults (Grundy and Holt, 2001; Lahelma *et al.*, 2004). Thus, this study will examine whether the varying amount of SES changes within the three welfare clusters correspond in differentiated changes in the magnitude of health inequalities between women and men. The research question is 'does the impact of SES on health after midlife vary among women and men depending on the welfare cluster?'

As explained above, a core element of our theoretical expectations is that if the welfare state decommodifies labour (Esping-Andersen, 1990) as well as health (Bambra, 2005a,b, 2007b), then there should be a weaker association between SES and health—for both women and men—living in highly decommodifying welfare states (Denmark and Sweden). Since these latter countries are also characterized by higher levels of defamilization (Bambra, 2004, 2007a), our hypothesis is that *compared with men, SES is expected to be weakly associated with health changes for women living in countries with high defamilisation and decommodification* (Denmark and Sweden). By contrast, always comparing with men, we expect SES to have a stronger impact on health changes for women living in the Southern European countries (Italy and Spain), due to their lowest levels of defamilization and less generous levels of welfare provision as compared to other European countries.

Data and Methods

Data and Sample

We use individual-level panel data from the Survey of Health, Ageing and Retirement in Europe (SHARE).

SHARE is a multidisciplinary, cross-national, and longitudinal research project focusing on adults aged 50 or older living in residential households (Börsch-Supan *et al.*, 2013). The survey includes detailed information about demographics, family structure, SES, and health. SHARE data collection is based on computer-assisted personal interviewing. Sampling strategies varied by country. Detailed information about the entire SHARE project is available at www.share-project.org.

This study uses data from the first (2004–2005), second (2006–2007), fourth (2011–2012), fifth (2013), and sixth (2015) wave of SHARE. The retrospective third wave of SHARE (SHARELIFE), carried out in 2008–2009, was excluded from the analyses as it focuses only on the respondents' life histories and because the questionnaire and variables are very different from the core data. However, we used information from the third wave to identify respondents who exited the panel (i.e. respondent's death year).

The analytical sample includes data from nine European countries (Austria, Belgium, Denmark, France, Germany, Italy, Spain, Sweden, Switzerland) and consisted of 13,955 respondents (50,459 observations) of age 50 and older, who were present in the first wave of SHARE. Since the health outcome of interest was *change* in frailty levels, we restricted the sample to any individual participating in at least two waves. The overall response rate at baseline was 61.8 per cent, ranging from 37.6 per cent (Switzerland) to 73.6 per cent (France) (De Luca and Peracchi, 2005). Out of the 21,407 respondents in the first wave of SHARE, 19,078 (89.1 per cent) provided valid information for the variables used in this study, and 13,955 of them (65.2 per cent) participated in at least one follow-up measurement. In total, these respondents provided 50,459 observations across five waves of SHARE ($n_{2004/2005}$ = 13,955, $n_{2006/2007}$ = 12,157, $n_{2011/2012}$ = 8,896, n_{2013} = 8,137, and n_{2015} = 7,314), which is an average of 3.6 observations per person. Of the initial respondents, 18.4 per cent (3,939) died within 11 years of follow-up after the first interview. Additional detailed information on survey participation, response rates, panel retention, and sample design of the SHARE survey is available elsewhere (De Luca and Peracchi, 2005; Bergmann *et al.*, 2017). Table 1 reports the characteristics of the analytical sample.

Table 1. Descriptive statistics of variables in the analyses

	Whole Sample (*N* = 50, 459) % (Mean)	Men (*N* = 23, 382) % (Mean)	Women (*N* = 27, 077) % (Mean)
Age[a]	(67.93)	(67.97)	(67.90)
Gender			
Male	46.34		
Female	53.66		
Frailty Index (FI)[a]	(0.12)	(0.11)	(0.14)
Education			
Low	47.11	42.53	51.07
Medium	31.36	33.35	29.64
High	21.53	24.13	19.29
Income			
1st quartile	25.05	21.61	28.02
2nd quartile	25.00	24.25	25.65
3rd quartile	25.00	25.92	24.20
4th quartile	24.95	28.21	22.13
Wealth			
1st quartile	25.05	22.74	27.04
2nd quartile	24.99	25.38	24.66
3rd quartile	25.02	25.60	24.52
4th quartile	24.94	26.29	23.78
Marital status			
Married	72.31	81.07	64.75
Never Married	5.47	5.56	5.40
Divorced	7.33	6.21	8.30
Widowed	14.88	7.17	21.54
Number of children			
Childless	9.73	10.04	9.46
1	17.39	16.62	18.06
2	37.75	38.43	37.16
3+	35.13	34.91	35.33
Wave			
[1] 2004–2005	27.66	27.71	27.61
[2] 2006–2007	24.09	24.40	23.83
[4] 2011–2012	17.63	17.57	17.68
[5] 2013	16.13	16.04	16.20
[6] 2015	14.49	14.28	14.68
Welfare cluster			
Southern Europe			
Italy	12.12	11.85	12.35
Spain	10.08	9.70	10.40
Western Europe			
Austria	6.59	6.21	6.91
Germany	9.98	10.23	9.76
France	12.76	12.09	13.34
Switzerland	4.93	4.93	4.93
Belgium	19.51	20.12	18.98
Northern Europe			
Denmark	8.98	9.32	8.69
Sweden	15.05	15.55	14.63

Note: Unless otherwise indicated, values are reported in percentages. Unweighted pooled dataset (Individual-Year, *N* = 50,459).

Source: SHARE data, years 2004–2015 (own estimates).

[a]Continuous variable: mean (in brackets).

Dependent Variable: Frailty Index

For a dependent variable, we use a 40-item FI of accumulated deficits, constructed in accordance with standard procedures (Searle *et al.*, 2008; Romero-Ortuno and

Kenny, 2012). Frailty is considered a comprehensive concept and measure of health at older ages and it is highly predictive of subsequent adverse health outcomes (Fried *et al.*, 2001; Romero-Ortuno and Kenny, 2012). Current deficits used to construct the dependent variable are measured at each wave of SHARE and include objective health markers (grip strength), weight loss (body mass index deficit), functional impairments in personal and instrumental activities of daily living, self-reported health and comorbidities, mood (sadness or depression, lack of enjoyment, etc.), limitations in cognition (impaired orientation to date: day, month, year, and day of the week, etc.), and other measures (see Supplementary Table A1). Each individual's deficit points were summed and divided by the total number of deficits evaluated (in our case 40) to obtain a FI with a theoretical range from 0 (no deficits present) to 1 (all deficits present). For example, a respondent with five deficits would have a FI value of 0.125 (5/40). Higher values indicated a greater number of health problems and hence greater frailty. The reliability coefficient, Cronbach's alpha, for the 40 items, is 0.861, which is commonly considered adequate to sum the items to a scale. The distribution of the FI approximately showed a gamma distribution. Missing values for each item were negligible: except for grip strength (8.58 per cent of missing), all items showed less than 4 per cent missing values. Full information on the FI deficit variables and cut-off points, are reported in Supplementary Table A1.

Independent Variables

Gender and SES are the key independent variables. SES is operationalized using three indicators, namely education, income, and wealth. Education is based on the international classification ISCED-97 and refers to the respondent's highest level of education. We classified education as low (ISCED 0, 1, and 2), medium (ISCED 3 and 4), and high (ISCED 5 and 6). This variable is collected only in the baseline interview and contained 1.83 per cent missing cases. Country and wave-specific quartiles of income and wealth were estimated at the household level and adjusted for family size (by dividing the variables by the square root of household size). Income and wealth were calculated based on an average of the five imputations provided in SHARE, which compensate for nonresponse. These two measures were assessed in each wave of the survey and refer, by survey design, to the year preceding the measurement of the dependent variable (i.e. the reference period ranges from time $t - 1$ and t).

Control variables include age, age-squared, age-cubed (to allow for nonlinear relations), current marital status (four categories: married[1]; never married; divorced; widowed), current number of children (childless, 1, 2, 3+), SHARE waves, and country of residence. SHARE collected information on marital status and number of children in each wave of the study. We added these two control variables into the models due to their associations with SES and health (Ross and Bird, 1994; Grundy and Holt, 2000; Lahelma *et al.*, 2002; Grundy and Sloggett, 2003; Lersch, Jacob, and Hank, 2017; Delaruelle, Buffel, and Bracke, 2018). For all the control variables, missing values were below 2 per cent.

Classification of Countries

Assuming relative homogeneity of the key features of their socioeconomic institutions and policies (Maître, Nolan, and Whelan, 2005), we classified the nine European countries into three generic welfare clusters, which roughly represent different welfare state regimes and geographical regions (Avendano, Jürges, and Mackenbach, 2009):

- *Northern Europe* (Denmark and Sweden). In accordance with the Esping-Andersen (1990, 1999) and other typologies (e.g. Ferrera, 1996), these two countries are classified as social democratic welfare states. The welfare policies of Denmark and Sweden, characterized by a universalistic approach to social rights, show high levels of defamilization (Bambra, 2004, 2007a). In addition, they promote gender equality both on the labour market and in the care responsibilities, actively supporting dual-earner household arrangements (Korpi, 2000), in particular in families with young children (Gauthier, 2002).
- *Southern Europe* (Italy and Spain). These countries have been classified as a distinct welfare state regime (Ferrera, 1996; Eikemo *et al.*, 2008) because of their specificities: they are characterized by a sub-protective and more fragmented system of welfare provision with a higher reliance on family support as a form of welfare provision compared to other European countries (Bambra, 2007b). The state support to families is extremely limited and women are encouraged to take up the family and care responsibilities (Bambra, 2007a,b).
- *Western Europe* (Austria, Belgium, France, Germany, and Switzerland). These countries are classified in a different way according to the typology applied. They belong to the Bismarckian cluster in the Ferrera (1996) typology, but some of them are recognized as conservative by others (Arts and Gelissen, 2002). Generally, these countries represent a different regime than the Southern or Northern (Esping-Andersen, 1990, 1999), although there is not yet full agreement and some of them may share

common characteristics with countries belonging to other welfare state regimes.

Analytic Strategy

Statistical analysis is conducted using linear hybrid models (Allison, 2009; Bell and Jones, 2015; Bell, Fairbrother, and Jones, 2018) and it aims at evaluating the associations between SES and frailty separately for each welfare cluster and gender. In doing so, we follow the procedure described by Schunck (2013). Hybrid models are random-effects models that allow for separate within-cluster effects (i.e. fixed-effects estimates) and between-cluster effects (Bell, Fairbrother, and Jones, 2018). Hence, like fixed-effects methods, hybrid models can control for time-constant unobserved individual heterogeneity (Allison, 2009; Bell and Jones, 2015; Schunck, 2013; Bell, Fairbrother, and Jones, 2018). The great advantage of this approach is that it permits the inclusion of time-invariant variables (e.g. gender) in a fixed-effects framework. Before clustering the countries, we fitted separate hybrid models by country to check the similarity between the single country estimates (for details, see Supplementary Table A2)[2].

Since a low level of education can lead to a low income and, consequently, to a low wealth, which in turn affect negatively health status (Lahelma *et al.*, 2004), we estimated three models for each country and gender: the first contains only education and all the basic control variables, the second adds dummies for each income quartile, and the third adds dummies for each wealth quartile. The first model allows us to estimate the total effect of education on frailty (Model 1), while the second and third models estimate respectively the total effect of income (Model 2, net of education) and wealth (Model 3, net of education and income). Moreover, the modifying effect of gender on the SES-frailty association was evaluated by including a product term between gender and each SES measure in separate regression models for all older adults combined[3].

In epidemiological literature, researchers have stressed that measuring effects on the additive scale is most appropriate for assessing the public health relevance of an exposure (Knol and VanderWeele, 2012). Contrary to multiplicative models (e.g. Poisson or log-linear models), modelling the FI in linear hybrid models allow us to measure effect modification on the additive scale.

Changes in the FI can be related to different types of attrition, including gender-specific health-related nonresponse, or selective mortality by gender. To adjust for sample loss due to attrition we estimated the regression models using inverse probability weighting (IPW). To calculate the weights, we have estimated a series of logistic regression models for response versus nonresponse in wave t as a function of independent variables (X_{t-1}) in a previous wave $t - 1$, conditional on having participated in wave $t - 1$ (Wooldridge, 2002; Tchetgen *et al.*, 2012). The variables included in the models to calculate the inverse probability weights were the FI, gender, age, education, income, wealth, marital status, number of children, and country of residence. For each observation, we computed the inverse of the predicted probabilities from these models ($1/\hat{p}_t$) and then used them to weight each observation in the multivariate analysis. The use of IPW as method to adjust for attrition gives more weight to those individuals with key demographic, socioeconomic, and health factors leading to a high probability of dropping out of the panel.

Since the violation of homoscedasticity assumption may be present when the dependent variable of linear regression models is not symmetric, we computed robust standard errors to relax the assumption of absence of heteroscedasticity. All analyses are performed using Stata 15.1.

Results

Figures from 1 to 3 present the estimates from multivariate hybrid models which investigated—separately for welfare clusters and gender—associations between SES and frailty, controlling for time-constant unobserved heterogeneity at the individual level (full model estimates in tabular form are shown in Supplementary Table A3). The upper panel of the figures reports the within-effects (i.e. longitudinal) estimates, thus only considering variance within individuals. The lower panel presents the between-individual (i.e. cross-sectional) estimates. Filled circles represent the estimates obtained when controlling for socio-demographic variables and level of education (Model 1), while hollow rhombuses refer to estimates from models that also include quartiles of income (Model 2) and filled squares refer to estimates from models that add quartiles of wealth (Model 3). When interpreting the results from the regression analyses, it is important to note that the variation for the FI and SES measures is mainly driven by between-individual variance. However, there is also enough within variance to justify a fixed-effect approach (Table 2 and 3).

The main results are as follows. In all the three welfare clusters there is a statistically significant and clear educational gradient in frailty for both genders (Figures 1–3, Model 1). In line with our expectations, the educational gradient appears to be strongest for women living in Southern European countries, less strong in Western European countries, and smallest in Northern European

Table 2. Variance composition for Frailty Index

		Mean	SD	Min	Max
Frailty Index (FI)	Overall	0.124	0.105	0	0.838
	Between		0.096	0	0.733
	Within		0.053	−0.259	0.575

Note: Individual-Year, $N = 50{,}459$.
Source: SHARE data, years 2004–2015 (own estimates).

Table 3. Variance composition for level of education, income, and wealth

Variables	Overall		Between		Within
	N	%	*N*	%	%
Level of Education					
Low	23,771	47.11	6740	48.30	100.00
Medium	15,823	31.36	4365	31.28	100.00
High	10,865	21.53	2850	20.42	100.00
Total	50,459	100.00	13,955	100	100.00
Income					
First quartile	12,640	25.05	6,930	49.66	52.07
Second quartile	12,617	25.00	7,626	54.65	46.06
Third quartile	12,613	25.00	7,613	54.55	44.97
Fourth quartile	12,589	24.95	6,556	46.98	52.02
Total	50,459	100.00	28,725	205.84	48.58
Wealth					
First quartile	12,639	25.05	5,806	41.61	63.17
Second quartile	12,611	24.99	6,980	50.02	49.96
Third quartile	12,625	25.02	7,086	50.78	48.44
Fourth quartile	12,584	24.94	5,764	41.30	58.43
Total	50,459	100.00	25,636	183.7	54.44

Note: Individual-Year, $N = 50, 459$.
Source: SHARE data, years 2004–2015 (own estimates).

countries. In the case of Southern Europe (Figure 1, Model 1), for example, a woman's FI is lower by 0.056 points if she belongs to the highest level of education instead of the lowest one (95 per cent CIs: −0.071, −0.040; $P < 0.001$). This means that lower-educated Southern European women report at least two more deficits than higher-educated women in the 40-item FI. Including additional controls for quartiles of income (Figures 1–3, Model 2) reduces the magnitude of the educational coefficients, but does not alter the overall pattern. However, in this case, the total effect of income appears to be smallest for both men and women living in Southern European countries. Moreover, once relying solely on within-individual variance, the longitudinal association between income and frailty is not statistically significant ($P > 0.05$).

Model 3 (Figures 1–3) adds quartiles of wealth to Model 2. Considering the between variance, the results show a clear wealth gradient in frailty, which appears to be less steep for men living in Southern European countries and for both women and men living in the Scandinavian countries. Similarly to income (Model 2), when relying exclusively on within-individual variance, the longitudinal association between wealth and frailty is not statistically significant ($P > 0.05$). The exception being women living in Western European countries (Figure 2, Model 3), where we find that a woman's FI rises by 0.007 points if she drops from the 3rd quartile of wealth to the 1st quartile (95 per cent CIs: −0.013, −0.002; $P < 0.01$). Despite this effect size is negligible, a Wald test confirms this result ($P < 0.01$), indicating that wealth has an overall longitudinal impact on the frailty levels of Western European women. It is interesting to note that the level of education has a statistically significant indirect effect, even after controlling for both income and wealth (Figure 1–3, Model 3).

To substantiate these findings, we evaluated potential effect modification of gender on the relationships between SES and frailty including gender and SES interaction terms in separate regression models for all older adults combined. Table 4 shows the results from these linear hybrid models, estimated separately for each welfare cluster (see Supplementary Table A4 for full model estimates). Turning to our research question, Table 4 shows that the association between SES and frailty is stronger for women than for men in Southern (education and wealth) and in Western European countries (only for education), as indicated by the statistically significant effect modification of gender in those contexts (between-individual estimates). For example, we find that Southern European women are more vulnerable than men to the influence of wealth in terms of frailty: a woman's FI drops by 0.037 points if she belongs to the 4^{th} quartile of wealth instead of the 1st quartile (95 per cent CIs: −0.066, −0.009; $P < 0.01$). The results of Wald tests confirm that the interaction terms are jointly different from zero ($P < 0.05$).

As a robustness check, we estimated a fully interacted hybrid model to examine whether SES-related changes in the FI differed significantly by gender and welfare cluster (results available on request), and then a Wald test on the joint significance of all the interaction terms between welfare cluster, gender and the three measures of SES. The test rejects the null hypothesis of equality of the coefficient for education only ($P < 0.001$). Since the time frame (i.e. the sequencing of the independent, control, and dependent variable) may be relevant for the analyses using fixed-effects models

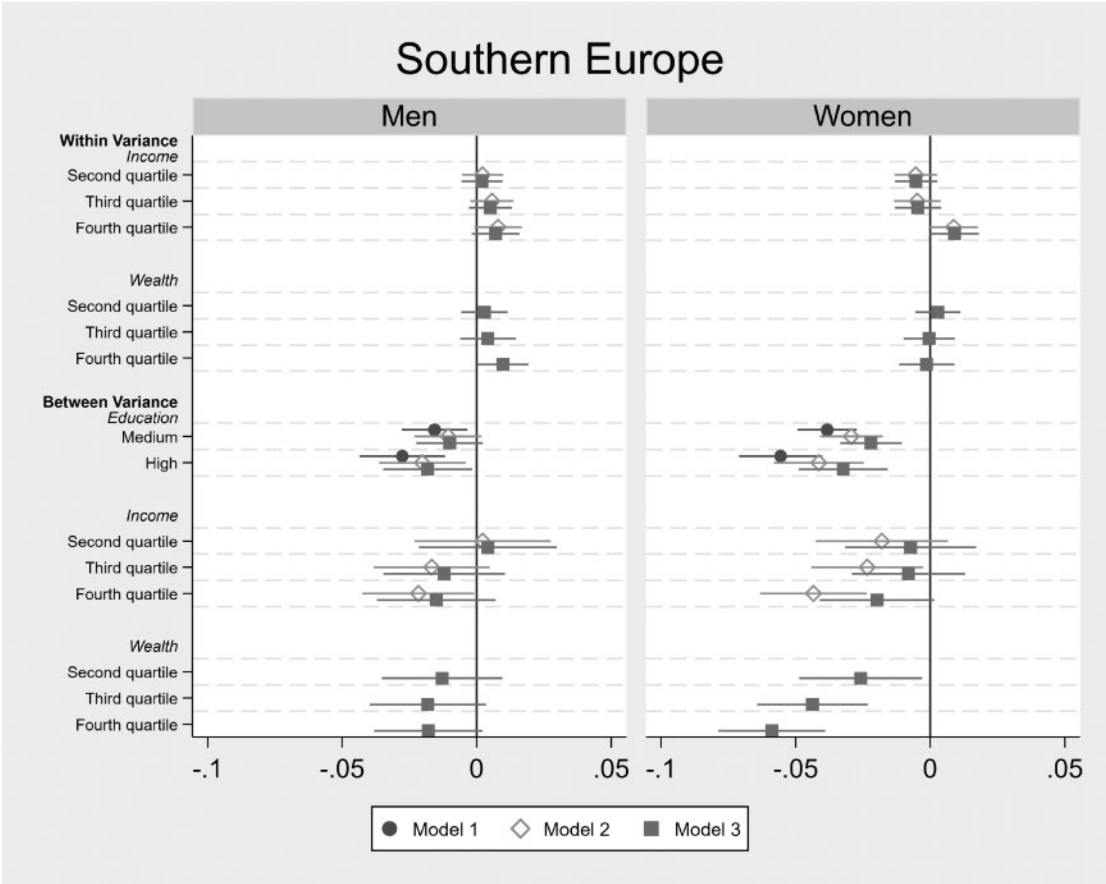

Figure 1. Linear hybrid models predicting frailty, by gender (Southern Europe). Estimates and 95 per cent confidence intervals.

Note: Filled circles indicate estimates from models with level of education and sociodemographic controls only (Model 1); hollow rhombuses refer to models with additional controls for quartiles of income (Model 2); filled squares indicate estimates from models that add quartiles of wealth (Model 3). Models include all the control variables. Complete models are displayed in Supplementary Table A3.

Source: SHARE data, years 2004–2015 (own estimates).

(Nyberg *et al.*, 2017), we additionally adopted a more restrictive 'time-adjusted' analysis: to overcome possible endogeneity issues, we lagged independent and control variables by one period relative to the dependent variable, which reduced the final sample to 36,504 observations from 13,955 individuals. The results hardly changed after allowing for lagged relationships (results available upon request).

Discussion and Conclusion

In this study, we have analyzed how the longitudinal associations between SES and health after midlife differs by gender and macro-level context in a sample of individuals aged 50 and above living in 9 European countries. Previous literature suggests that some of the complex relationships found between gender and health may be driven by individual socioeconomic factors as well as by the macro-level contexts in which individuals live. Our study makes a significant contribution to the literature on gender inequalities in health in later life by investigating the longitudinal associations between three measures of SES (education, income, and wealth) and frailty, a multi-dimensional comprehensive concept and measure of health. We tested these associations using comparative cross-national data and estimating 'hybrid' (between-within) regression models in different European welfare state clusters (Southern, Western, and Northern).

Considering only the between-individual variance in the hybrid models, our results support the cross-

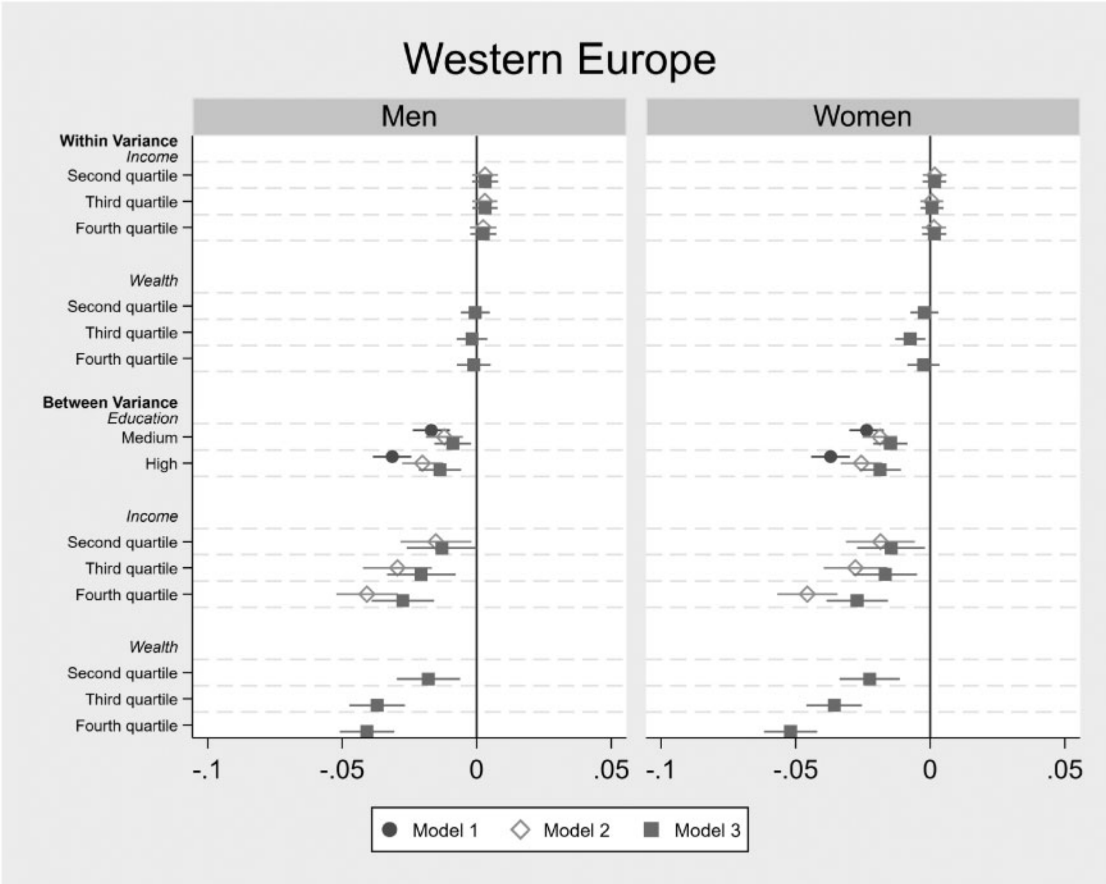

Figure 2. Linear hybrid models predicting frailty, by gender (Western Europe). Estimates and 95 per cent confidence intervals.

Note: Filled circles indicate estimates from models with level of education and sociodemographic controls only (Model 1); hollow rhombuses refer to models with additional controls for quartiles of income (Model 2); filled squares indicate estimates from models that add quartiles of wealth (Model 3). Models include all the control variables. Complete models are displayed in Supplementary Table A3.

Source: SHARE data, years 2004–2015 (own estimates).

sectional findings that SES, as predictor of health in later life, does not have the same impact across gender within different socioeconomic contexts. What our results clearly show is that only in Southern (Italy and Spain) and Western European countries (Austria, Belgium, France, Germany, and Switzerland) the impact of education and wealth on health is stronger for women. Conversely, in Northern Europe (Denmark and Sweden) we did not observe any gender difference according to SES. The fixed-effects estimates from the hybrid models show that the intra-individual change in income and wealth does not cause a substantive change in health after midlife. Hence, our results partially corroborate the hypothesis that the longitudinal influence of SES—and, most importantly, the effect modification of gender—on health after age 50 is weaker in countries with high defamilization and decommodification. This is in line with the previous literature, since frailty-free life expectancy is lower for women than men, but these differences are less marked in Sweden and Denmark (Romero-Ortuno, Fouweather, and Jagger, 2014). However, the fixed-effects estimates suggest that income and wealth might have only limited impact on health after midlife, while models with between-variation components might overestimate the influence of SES on health because they do not control for unobserved (time-constant) heterogeneity at the individual level. Moreover, while statistically significant, the effect sizes of the three measures of SES found in this study are not large.

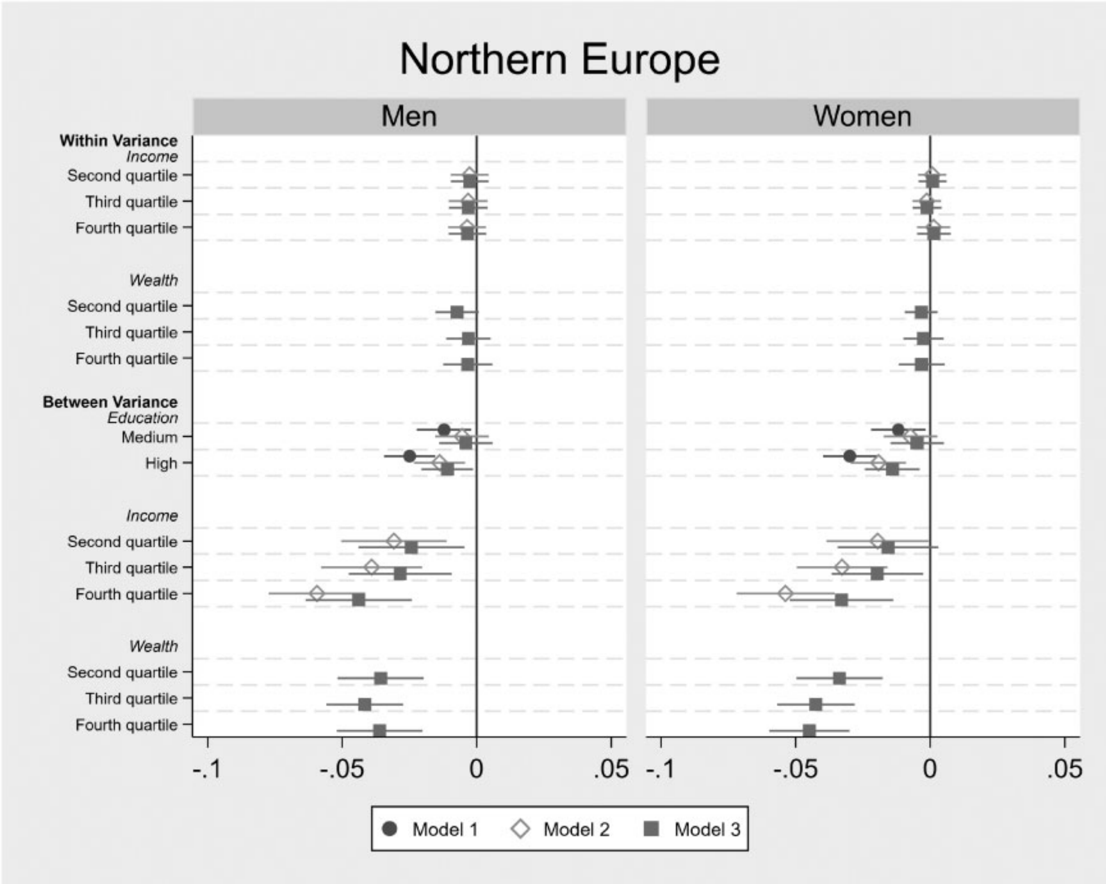

Figure 3. Linear hybrid models predicting frailty, by gender (Northern Europe). Estimates and 95 per cent confidence intervals.

Note: Filled circles indicate estimates from models with level of education and sociodemographic controls only (Model 1); hollow rhombuses refer to models with additional controls for quartiles of income (Model 2); filled squares indicate estimates from models that add quartiles of wealth (Model 3). Models include all the control variables. Complete models are displayed in Supplementary Table A3.

Source: SHARE data, years 2004–2015 (own estimates).

Several explanations may account for the international variations observed between individuals. On the one hand, at least part of the variation can be ascribed to the more generous, decommodifying welfare state policies of the Scandinavian countries (Esping-Andersen, 1990, 1999), since they can protect better against the health effects of low SES (Bambra, 2005a). Evidence of this is that there are weaker associations between education and factors subject to welfare state policy interventions (e.g. employment, income, wealth) in the Northern than in Southern or Western European countries (Avendano, Jürges, and Mackenbach, 2009). Moreover, the more equal distribution of these resources in the Northern European countries, combined with the highest levels of defamilization (Bambra, 2004, 2007a), may have contributed to smaller gender inequalities in health than in the less redistributive and less protective Southern and Western European countries.

On the other hand, we recognize the possibility that other factors, unobserved in our study, can account for these macro-level variations. Cross-national differences in the quality and stratification of the use of healthcare (van Doorslaer, Masseria, and Koolman, 2006) – combined with the fact that women have a higher frequency of healthcare utilization than men (Bird and Rieker, 1999; Zajacova, Huzurbazar, and Todd, 2017)—may also account for some of these differences. This study recommends that future studies should more carefully investigate these and other potential pathways.

Table 4. Linear hybrid models predicting frailty, by welfare cluster. Beta coefficient (first column) and 95 per cent confidence intervals (second column)

	Southern		Western		Northern	
	β	95% CI	*β*	95% CI	*β*	95%CI
Within variance						
Income (ref.: 1st quartile)						
2nd quartile	0.002	−0.006, 0.009	0.003	−0.002, 0.008	−0.003	−0.010, 0.004
3rd quartile	0.004	−0.004, 0.012	0.003	−0.002, 0.008	−0.003	−0.011, 0.004
4th quartile	0.006	−0.003, 0.015	0.002	−0.002, 0.007	−0.003	−0.010, 0.004
Wealth (ref.: 1st quartile)						
2nd quartile	0.003	−0.006, 0.012	0.000	−0.006, 0.005	−0.007	−0.016, 0.001
3rd quartile	0.004	−0.006, 0.015	−0.001	−0.007, 0.004	−0.003	−0.011, 0.005
4th quartile	0.010*	0.000, 0.019	−0.001	−0.007, 0.006	−0.003	−0.012, 0.006
*Interaction: Gender * Income*						
Women * 2nd quartile	−0.007	−0.018, 0.004	−0.001	−0.008, 0.005	0.004	−0.005, 0.013
Women * 3rd quartile	−0.009	−0.021, 0.003	−0.002	−0.009, 0.004	0.002	−0.007, 0.011
Women * 4th quartile	0.003	−0.010, 0.016	−0.001	−0.007, 0.006	0.004	−0.005, 0.013
*Interaction: Gender * Wealth*						
Women * 2nd quartile	0.000	−0.012, 0.012	−0.002	−0.009, 0.006	0.005	−0.006, 0.015
Women * 3rd quartile	−0.005	−0.019, 0.009	−0.006	−0.014, 0.002	0.001	−0.010, 0.012
Women * 4th quartile	−0.011	−0.025, 0.003	−0.002	−0.011, 0.007	0.000	−0.013, 0.012
Between variance						
Level of Education (ref.: Low)						
Medium	−0.005	−0.017, 0.008	−0.006	−0.013, 0.001	−0.003	−0.013, 0.007
High	−0.015	−0.032, 0.001	−0.012**	−0.020, −0.004	−0.011*	−0.020, −0.001
Income (ref.: 1st quartile)						
2nd quartile	0.000	−0.026, 0.025	−0.015*	−0.027, −0.002	−0.025*	−0.044, −0.006
3rd quartile	−0.014	−0.036, 0.009	−0.022***	−0.034, −0.009	−0.026**	−0.045, −0.008
4th quartile	−0.012	−0.034, 0.010	−0.027***	−0.039, −0.016	−0.040***	−0.059, −0.022
Wealth (ref.: 1st quartile)						
2nd quartile	−0.011	−0.034, 0.011	−0.018**	−0.030, −0.007	−0.037***	−0.053, −0.021
3rd quartile	−0.018	−0.040, 0.003	−0.037***	−0.047, −0.027	−0.043***	−0.057, −0.029
4th quartile	−0.020	−0.040, 0.000	−0.041***	−0.051, −0.031	−0.037***	−0.053, −0.021
*Interaction: Gender * Level of education*						
Women * Medium	−0.021*	−0.038, −0.005	−0.011*	−0.020, −0.002	−0.002	−0.015, 0.011
Women * High	−0.021	−0.044, 0.002	−0.008	−0.018, 0.003	−0.003	−0.016, 0.010
*Interaction: Gender * Income*						
Women * 2nd quartile	−0.005	−0.040, 0.030	0.001	−0.017, 0.019	0.007	−0.019, 0.033
Women * 3rd quartile	0.006	−0.025, 0.036	0.006	−0.011, 0.023	0.002	−0.022, 0.025
Women * 4th quartile	−0.010	−0.040, 0.020	0.001	−0.015, 0.017	0.002	−0.022, 0.025
*Interaction: Gender * Wealth*						
Women * 2nd quartile	−0.014	−0.046, 0.017	−0.004	−0.020, 0.012	0.004	−0.018, 0.027
Women * 3rd quartile	−0.025	−0.055, 0.005	0.002	−0.013, 0.016	0.002	−0.018, 0.023
Women * 4th quartile	−0.037**	−0.066, −0.009	−0.011	−0.025, 0.003	−0.007	−0.028, 0.015
Gender (ref.: Men)						
Women	0.068***	0.044, 0.092	0.021**	0.006, 0.035	0.010	−0.011, 0.030
AIC	−29642.4		−89741.9		−41275.4	
BIC	−29217.6		−89233.0		−40838.6	
No. of observations	11200		27132		12127	
No. of groups (individuals)	3036		7615		3304	

Note: ref.: reference category. Models include all the control variables. The estimates of the control variables (age, age^2, age^3, marital status, number of children, SHARE waves, and country of residence) are found in Supplementary Table A4.

*$P < 0.05$.

**$P < 0.01$.

***$P < 0.001$.

Source: SHARE data, years 2004–2015 (own estimates).

The study has three noteworthy limitations that should be highlighted for future studies. First, all dimensions of frailty, except for maximum grip strength, are self-reported and may be sensitive to potential bias caused by cross-cultural (Jürges, 2007) and gender differences in reporting styles (Zajacova, Huzurbazar, and Todd, 2017). A possible solution could have been the use of additional information on reporting heterogeneity, examining variation in the evaluation of given health states represented by anchoring vignettes (King *et al.*, 2004). This would have resulted in a more robust analysis, purged from the individual's own health assessment. Unfortunately, the self-administered paper questionnaire containing vignettes has been administered only to a small sample and only in the first two waves of SHARE. Second, results may be affected by cross-national differences in the proportion of institutionalized older adults which are not surveyed in the first wave of SHARE. These two limitations could likely downward-bias the estimates of frailty in Northern European countries and upward-bias them in Southern European countries. Third, the analyses are based on five panel waves and this could limit the within-unit variation in the estimation of the parameters of the fixed-effect (hybrid) models. This may explain why the within-effects estimates were not statistically significant.

Despite the limitations outlined above, this study is, to our knowledge, the first longitudinal cross-national investigation of the magnitude of the relationship between SES and health in relation to gender in a sample of older adults over a 11-year period. This work stresses the important role of SES for maintaining good health at older ages, highlighting how education and wealth have a more powerful impact on health for older women living in the Southern and Western European countries than those living in the Northern European societies. This suggests that decommodifying and defamilializing welfare arrangements can reduce gender inequalities in health at later ages, especially amongst those from the lowest SES groups.

Notes

1 Respondents are considered "married" if they reported: (a) being married and living with the spouse; (b) being married but living separated from the spouse; (c) having a registered partnership.

2 To substantiate our findings, we also applied linear random-effects models (results available upon request).

3 Following the indications provided by Schunck (2013), we estimated the interactions separately for the within and between-effects.

Supplementary Data

Supplementary data are available at *ESR* online.

Acknowledgements

This study was carried out as part of the multi-country project 'Care, Retirement & Wellbeing of Older People Across Different Welfare Regimes' (CREW). The CREW project is funded by the Joint Programming Initiative "More Years Better Lives" 2017-2020 (https://crew-more-years-better-lives.org). This paper uses data from SHARE Waves 1, 2, 3, 4, 5 and 6 (DOIs: 10.6103/SHARE.w1.611, 10.6103/SHARE.w2.611, 10.6103/SHARE.w3.611, 10.6103/SHARE.w4.611, 10.6103/SHARE.w5.611, 10.6103/SHARE.w6.611), see Börsch-Supan *et al.* (2013) for methodological details. The SHARE data collection has been primarily funded by the European Commission through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812) and FP7 (SHARE-PREP: N°211909, SHARE-LEAP: N°227822, SHARE M4: N°261982). 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) and from various national funding sources is gratefully acknowledged (see www.share-project.org). The authors would like to thank the editors and the three anonymous reviewers for their helpful criticisms and suggestions, which have greatly improved the content of the paper. The usual disclaimers apply.

Funding

The authors acknowledge funding from ZonMw (The Netherlands Organization for Health Research and Development). Project Number: 633500001.

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