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Gender, Socioeconomic Status, and Health in Later Life

A Multilevel Analysis of the Frailty Index Across 17 European Countries

by

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This study aimed to examine if there are gender differences in health that vary by education after midlife (age 50 years) across 17 different European countries. Using data from the Survey of Health, Ageing and Retirement in Europe in 2015, the study applied multilevel linear regression models to investigate gender differences in frailty index. The results showed that the protective effect of education on frailty index is stronger for women than for men. Furthermore, the study found that the influence of education on health is more prominent for women than for men in Southern, Western, and Eastern European countries. However, in Northern Europe, no substantial gender disparity in health outcomes based on SES was observed. Lastly, the study highlighted an age-related gradient in gender disparities in frailty. The results of this study highlights the importance of taking into account the complex interaction between gender, education, health, and welfare regimes when designing policies and interventions to enhance the health of older populations.

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1 Introduction

The phenomenon of population aging has become a critical global concern, and Europe is at the forefront of this demographic shift. Over the past seven decades, the number of individuals aged 65 years and older in Europe has tripled, and it is projected that this trend will continue in the coming decades, leading to an even older population (United Nations, 2019). The European Commission (2021) estimates that between 2019 and 2070, the overall population in Europe will decrease by 5%, while the number of people aged 65 and over will nearly double. As the population ages, there is significant variation in health status, care requirements, and survival rates, with notable differences observed between genders. Despite the fact that women experience certain health advantages that contribute to their longer life expectancy, they also exhibit greater levels of disability, more comorbidities, and poorer self-rated health compared to males (Gordon et al., 2017).

The impact of gender-related health disparities among middle-aged and elderly individuals carries significant implications for government programs and society as a whole. The health of older individuals is of great concern as they are particularly vulnerable to chronic illness and generally report poorer health (Read & Gorman, 2010). Furthermore, their income typically decreases as they retire from the workforce, making them heavily reliant on pension systems and state welfare provisions. These characteristics make older women particularly vulnerable since they generally outlive men in most European countries. They are also more likely to become widowed or to care for a dependent partner (Carmel, 2019). Additionally, they often encounter pension systems that favor men (Högberg et al., 2017).

1.1 Research problem

A large volume of research has attempted to investigate gender health disparities in European countries (Bambra et al., 2009; Lahelma et al., 2002). However, the relationship between socioeconomic status and health in older men and women is still unclear, with studies reporting contradictory findings across health measures (Uccheddu et al., 2019; Read and Gorman, 2010). Empirical results suggest that men report more life-threatening conditions, such as stroke, cardiovascular diseases, or lung cancer, while women are more likely to suffer from nonfatal chronic conditions, such as arthritis, cognitive impairment, and depression, which negatively impact their well-being later in life (Case & Paxson, 2005; Read & Gorman, 2010). Additionally, the literature suggests that gender differences in health depend on the age group studied. Several studies indicate that as women grow older, their health disadvantages compared to men tend to decrease. More specifically it was found that women in their 60s and beyond have reported better self-perceived health than their male counterparts (McCullough & Laurenceau, 2004; Zajacova et al., 2017). However, contrasting findings suggest that gender

disparities in mental health and overall well-being tend to escalate with age, particularly among the elderly population (McDonough & Strohschein, 2003; Pinquart & Sörensen, 2001).

Furthermore, the direction and magnitude of gender differences in health vary across countries, suggesting that country-specific factors play a role in creating these disparities (Bambra et al., 2009; Crimmins et al., 2011; Delaruelle et al., 2018; Högberg, 2018). Uccheddu et al. (2019) found that the association between socioeconomic position and health was stronger for women than for men in Southern and Western European countries, while no gender differences were observed in Nordic countries. On the other hand, focusing on self-reported health, Gómez-Costilla et al. (2022) reported significant gender differences in health in Southern and Nordic countries. Previous research has shown that self-rated health is poorer among both men and women in Eastern European countries, although studies examining gender differences in these countries remain scarce (Deaton, 2008). Moreover, a growing body of literature suggests that gender differences in health appear to be more pronounced in Southern European countries compared to the rest of Europe (Aguilar-Palacio et al., 2018). Although a systematic review by Read, Grundy, and Foverskov (2015) found no consistent patterns in the association between self-rated health and socioeconomic position by gender.

Therefore, it is evident that gender health differences are not universally observed across age groups and health indicators, and the magnitude of the gender health gap varies across countries. This underscores the necessity for further research to develop a comprehensive understanding of gender health inequalities.

1.2 Aim and scope

The primary aim of this paper is to contribute to the understanding of how SES, gender, and health intersect and develop in later life. More specifically, to examine if there are gender differences in health that vary by education after midlife (age 50 years) across 17 different European countries. This study makes several contributions to the existing literature on gender health inequalities among older adults in Europe. Firstly, this study aims to address the current gap in research by utilizing a more comprehensive and objective measure of health, namely the frailty index. This measure offers a more thorough assessment of older adults' overall health and has been consistently shown to be a robust predictor of adverse health outcomes (Fried et al., 2001; Romero-Ortuno & Kenny, 2012). Secondly, the study will examine the intersection of socioeconomic status and gender, shedding light on how gender disparities in health vary by SES. Additionally, the study considers the influence of different welfare regimes, providing a deeper understanding of how macro-level opportunities and constraints influence gender health disparities. Lastly, by examining gender health inequalities across different age groups, the study evaluates whether health inequalities decrease, remain stable, or increase with age.

To achieve these objectives, this study utilizes the Survey of Health, Ageing and Retirement in Europe (SHARE) dataset. SHARE has been a valuable resource for scholars investigating gender disparities in health among individuals in middle and old age, as it provides comprehensive data on the aging population in Europe.

1.3 Research questions

To achieve the research goal, this thesis tries to answer the three research questions below:

RQ 1: Are there gender differences in health that vary by socioeconomic status among middle- and old-aged men and women in Europe?

RQ 2: Does the influence of socioeconomic status on gendered health outcomes vary based on the type of welfare regime in place?

RQ 3: Does the influence of socioeconomic status on gendered health outcomes across welfare state regimes vary between different age groups?

1.4 Outline of the Thesis

This paper is structured in the following manner: in the second section, the theoretical framework and past studies on health inequalities are critically examined, including the primary explanation of these disparities, the influence of welfare state regimes, and the impact of age, and how these factors contribute to gender health inequalities. Section 4 provides a detailed description of the data from the Survey of Health, Ageing and Retirement in Europe (SHARE), including how each variable is defined. In section 5, the empirical methodology is outlined. The following section presents the main findings of the empirical analysis, while section 7 offers a further discussion of the results. Finally, section 8 provides a summary of the research, highlights the limitations of the study, and offers suggestions for future studies.

2 Theory and previous research

2.1 Theoretical Approach

2.1.1 Health inequality

Health inequalities refer to the systematic variations in the health of individuals belonging to different social positions (Graham, 2009). Such inequalities are observed across multiple dimensions of social stratification, including gender, age, income, social class, race or ethnicity, and geographic location (McCartney et al., 2013). When investigating health inequalities, researchers consider various research structures. Specifically, when selecting a particular aspect of health, the studies explore either differences in health status, healthcare service utilization, or healthcare financing (Gwatkin, 2000). Given the objective of this thesis to examine gender health disparities among older adults across different European welfare state regimes, this research will focus on differences in health status among individuals.

There are various ways researchers measure differences in health status across individuals. One commonly employed health metric is self-reported health (Gómez-Costilla et al., 2022). The use of self-reported health as a measure has a long history, as previous research has shown a strong association between self-reported health and mortality rates in both the general population and older individuals (Lee, 2000). Another health measure used in many studies is chronic conditions encompassing illnesses like hypertension, diabetes, stroke, and respiratory diseases (Leopold, 2018). Measuring chronic conditions has two crucial advantages. First, individuals are at varying risk levels of developing one or more of these conditions, based on their long-term habits and exposure to various health stressors. Second, this measure does not rely on self-evaluations by participants. A potential concern when comparing chronic conditions across countries is variations in access to healthcare and differences in medicalization levels (Strum, 2002). For example, individuals with lower education in some nations may have to bear greater costs to see a doctor, resulting in fewer diagnoses. On the other hand, countries with a higher degree of medicalization may have a greater tendency for individuals to consult doctors even for minor health issues, leading to a higher prevalence of diagnoses without necessarily indicating higher actual illness rates (Crimmins et al. 2011).

Frailty is another health indicator used to refer to a syndrome linked to aging, which is defined by the depletion of physiological reserves and is connected to negative outcomes such as hospitalization, falls, worsening disability, and mortality (Kojima et al., 2018). The literature identifies two of the most popular operational definitions of frailty as the frailty phenotype and the frailty index (Fried et al., 2001; Mitnitski et al., 2001). These definitions come from diverse theoretical frameworks. According to Fried et al. (2001), the frailty phenotype defines frailty as a biological syndrome with distinct phenotypic presentations that require three or more

physical components out of five to be present. Such components are self-reported exhaustion, weakness, weight loss, low physical activity, and slow walking speed. While this definition is well-validated and widely used, it has been criticized for being too narrow in focus and excluding potentially important components of frailty, such as cognitive impairment (Clegg et al., 2016). In contrast, the frailty index proposes that frailty arises from the accumulation of health deficits throughout one's lifetime (Mitnitski et al., 2001). The greater the number of deficits an individual possesses, the higher their likelihood of being classified as frail. Deficits can include diseases, signs, symptoms, disabilities, and social characteristics as well as radiographic, laboratory, or electrocardiographic abnormalities (Kane et al., 2012).

2.1.2 Gender Inequalities in Health

The male-female health survival paradox is a well-documented phenomenon that has been extensively studied (Oksuzyan et al., 2010). This paradox describes the fact that, on average, women tend to live longer than men, yet they also tend to experience more health issues over the course of their lives. Scholars have proposed three explanations for the gender differences in health, which include biological, behavioral, and social factors (Read & Gorman, 2010). Biological explanations consider the role of hormones, genetics, and chronic disease differences across genders (Oksuzyan et al., 2010). Women tend to be biologically more robust than men due to the protective effect of estrogen, which can lower the risk of heart disease by reducing harmful cholesterol levels (Owens, 2002). Conversely, testosterone in men can lead to immunosuppression and an increased risk of life-threatening conditions. However, due to their inability to explain the differences in gender health disparities over time and across social groups, biological explanations are seldom discussed in sociological studies of gender disparities in health (Oksuzyan et al., 2010).

Numerous studies have examined the differences between men and women in terms of their participation in behaviors that either enhance or damage their health (Read & Gorman, 2010). Generally, men are more likely to engage in harmful behavior, and this may explain why adjusting for behavioral factors tends to reduce the gap in mortality rates between men and women. Studies have found that men receive fewer preventive healthcare visits than women, and they have higher rates of smoking and alcohol consumption (Crimmins et al., 2002; Denton et al., 2004). It is also argued that men also are more susceptible to the negative health effects of these behaviors compared to women (Denton & Walters, 1999). Consequently, these harmful behaviors contribute to men's increased rate of premature death.

In contrast to the biological and behavioral explanations, social explanations focus on the social and contextual factors that influence the behavior, social positions, and well-being of both men and women (Read & Gorman, 2010). Socioeconomic status (SES) is one of the most commonly cited factors that shape the health differences between men and women. SES is a crucial determinant of health outcomes, as it provides individuals with resources such as knowledge, money, power, and prestige that they can use to cope with illness and stressful events (Phelan et al., 2010; Read & Gorman, 2010). For instance, women's lower SES, relative to men, limits their access to health-related resources and contributes to poorer health outcomes (McDonough & Walters, 2001; Östlin, 2002). When investigating the role of socioeconomic status as a determinant of health outcomes, researchers commonly use objective indicators such as income,

education, and occupation. However, among middle-aged and older individuals, there is a lack of consensus among scholars regarding the most appropriate indicator to employ (Gómez-Costilla et al., 2022). For example, occupation may not be a suitable measure for the elderly population due to retirement or lack of work experience. Similarly, income or wealth measures may not accurately reflect a lifetime position due to temporary fluctuations. Therefore, to account for the lifetime position of the individual, education is often used as a proxy for SES. However, this measure may be skewed among older individuals due to low average education levels (Huisman et al., 2003).

This thesis will focus on social factors as explanations for gender health disparities, as it recognizes the role of social and structural factors in shaping health outcomes. This approach acknowledges that health is not solely determined by biological or individual factors but is also influenced by social factors such as gender, race, socioeconomic status, and cultural norms.

2.1.3 Welfare state regimes and health inequalities

The "constrained choice" theory has been proposed to explain the gender disparities across various nations (Bird & Rieker, 2008). According to this theory, variations in health outcomes between women and men can be attributed to large-scale opportunities and limitations that impact individual choices and priorities related to health. The welfare state is a key player in promoting population health and gender equality in health, particularly in terms of how it interacts with the family (DiPrete, 2002). It can influence the daily lives of women and men in career options, employment and saving patterns, and care responsibilities (Bambra, 2007). The implementation of policies aimed at promoting gender equality by the welfare state can include measures such as encouraging women's employment, providing support for balancing work and family life, promoting various family models, and offering public childcare services. However, in later life, when employment and child-rearing are no longer central concerns, the protective role played by the state and family support becomes increasingly important as middle-aged and older individuals become more vulnerable, dependent, and experience a decline in social participation. This is especially true for the oldest old, for whom the pension system and social care provision become critical instruments of intervention (Bambra, 2007). To illustrate this point, Esping-Andersen (1990, 1999) developed a typology of three welfare regimes, the Social Democratic, the Continental, and the Liberal regimes, characterized by different configurations of state, market, and family in providing welfare benefits. Later research has also included Southern European and Eastern European regimes (Hemerijck, 2013). In this thesis, due to the nature of the SHARE data, which does not include the United Kingdom, four European welfare state regimes were considered: the Nordic (Social Democratic), the Western (Continental), the Southern European, and the Eastern European regimes.

The Nordic welfare state regime is characterized by a high degree of state involvement in social welfare (Kuisma & Nygård, 2015; Bambra, 2007). Compared to other welfare regimes, it is known to have relatively low levels of inequality and poverty among older individuals due to generous pensions and substantial state support (Fritzell et al., 2012). Moreover, this regime is characterized by a high degree of defamilization and decommodification which influences gender inequalities in health among middle-aged and elderly individuals. Defamilization is the ability of individuals to achieve a socially acceptable standard of living without relying on

family connections. Decommodification, on the other hand, is the extent to which individuals can achieve a socially acceptable standard of living without being dependent on the market (Bambra, 2007; Esping-Andersen, 1999).

The Western welfare state regime involves substantial state involvement alongside corporate actors, churches, and non-governmental organizations (Esping-Andersen, 1990). However, its focus on maintaining social rights that benefit individuals with steady employment and higher incomes, through relatively generous pensions, while providing lower means-tested benefits to those with lower incomes and precarious employment, along with a limited provision of public social services, has been associated with higher levels of inequality and poverty in old age (Schuldi, 2005). While the Western welfare state regime may also contribute to reducing gender-based health inequalities among older adults, it is expected to have a smaller impact than the Nordic welfare state regime. The social insurance policies in this regime provide protection against income loss due to unemployment, sickness, and old age, which may benefit women more than men due to their higher risk of income loss from family caregiving responsibilities (Bambra, 2007). However, the higher degree of familization in these countries, in combination with a less socially enabling welfare state, suggests that the gender gap in frailty among older people is higher than in Northern countries and conditioned by family ties.

In the Southern European welfare state regime social welfare is primarily provided by the family, local communities, and church (Esping-Andersen, 1999). Compared to the Nordic and Western regimes, the provision of public social services and pensions for older people is lower in the Southern European regime, resulting in high levels of inequality and poverty among older individuals (Ferrera, 1996). One notable aspect of this regime is its emphasis on the family as the main source of care and support for older people. In Southern European countries, women often bear a disproportionate burden of caregiving responsibilities within the family (Bambra, 2007). This can lead to increased stress, physical and emotional strain, and limited opportunities for self-care among women in later life. The cumulative effect of these caregiving responsibilities can have negative consequences for women's health, potentially leading to higher levels of stress-related illnesses, chronic conditions, and poorer overall health outcomes.

The Eastern European welfare state regime comprises countries that have distinct historical and institutional legacies, but which share a common history of communist rule for about half a century (Siegert, 2009). Following the post-communist era, these countries underwent a rapid transition from a universal social protection system to a more differentiated regime (Aidukaitė, 2009). While communism offered modest benefits and public services for the whole population, the post-1991 period has seen the emergence of some corporatist elements, such as earnings-related pensions for some groups, alongside liberal elements like means-tested benefits for older adults. While gender equality remains a priority in Baltic and Central Eastern European countries, there is significant reliance on the family as a primary source of support. Similar to the Southern European regime, formal care services for the elderly are limited in these countries (Siegert, 2009). Consequently, older individuals in this welfare regime face challenges in accessing appropriate healthcare and social care services, which can contribute to health inequalities and disparities, particularly among disadvantaged groups.

2.1.4 Age and health inequalities

It is essential to consider how age affects health inequality, in addition to examining disparities based on gender and socioeconomic status. There is a debate in the health inequality literature about how age affects inequality, with some arguing that it decreases, remains stable, or increases with age (Riley, Johnson & Foner, 1972). According to the aging-as-leveler hypothesis, health inequality should decrease as people age, leading to converging health outcomes, especially after midlife (Brown et al., 2012). According to this hypothesis, there are two primary mechanisms that contribute to this equalizing effect: mortality selection and the delayed onset and progression of illness resulting from the social and economic advantages of privileged populations. As a result, there is compressed morbidity to later life, where rapid declines in health occur more prominently among disadvantaged groups. Both processes are likely to reduce health inequalities at later ages (Dupre, 2007). In the context of this thesis, the aging-as-leveler hypothesis predicts that the negative impact of being a woman with low SES would decrease between middle and late life.

On the other hand, the persistent inequality hypothesis proposes that health disparities within a cohort remain constant throughout the life course (Henretta & Campbell, 1976). This hypothesis predicts that health advantages and disadvantages persist, with age not having an equalizing or amplifying effect. Lastly, the cumulative disadvantage hypothesis predicts that the health outcomes of individuals diverge as they age (Pavalko & Caputo, 2013). The cumulative disadvantage hypothesis suggests that initial advantages or disadvantages can have a snowball effect over time. Those who start with advantages are able to accumulate more resources and opportunities, allowing them to better avoid health risks. On the other hand, early-life disadvantages can lead to further risks and disadvantages as individuals age (Ferraro et al., 2009). This hypothesis, would imply that health disparities along gender and SES lines would increase between middle and late life.

2.2 Previous Research

2.2.1 Research on gender inequalities in health

The relationship between socioeconomic position and health in older men and women remains a topic of debate, with inconsistent findings reported by various studies. Cross-sectional studies from single countries, such as Finland and Northern Ireland, have failed to find any association between gender and SES using self-reported health and mortality as health measures among individuals older than 65 years (Connolly, O'Reilly & Rosato 2010; Sulander et al., 2009). However, other studies have shown mixed results depending on the health outcome under consideration. A study reporting the prevalence of cognitive function, grip strength, quality of life, and depressive symptoms using the Survey of Health, Ageing and Retirement in Europe (SHARE) data found that baseline household income and wealth were positively associated with improvements in various health indicators for both men and women (Ahrenfeldt & Möller, 2021). While most of these associations did not show any gender differences, the impact of cognitive function on income trajectories was stronger for women than for men. On contrary,

the impact of income on the enhancement of grip strength was more pronounced among men compared to women. Another study from Spain found that regions with lower levels of socioeconomic development exhibited poorer self-reported health, particularly among women (Rueda, 2012). On the other hand, one of the most socioeconomically advanced regions had the lowest mental health status, particularly among men.

2.2.2 Comparative studies

It is also important to consider in what ways socioeconomic status impacts the health of older individuals across nations, specifically with regard to gender. A plethora of comparative analyses examining the correlation between SES and health across European nations have yielded inconclusive outcomes in terms of the intersection between SES and gender (Gómez-Costilla et al., 2022; Scheel-Hincke et al., 2020; Ahrenfeldt et al., 2020; Uccheddu et al., 2019). Many studies examining gender health inequalities in Europe used the SHARE data. The SHARE data has been a valuable resource for scholars investigating gender disparities in health among individuals in middle and old age. As a cross-national survey, SHARE provides information about various dimensions of health and well-being, including physical and mental health, social relationships, economic status, and more (Börsch-Supan et al., 2013). As such, it has been a popular data source for studies seeking to explore the complex relationships between gender, socioeconomic status, and health outcomes among older adults. As a result, this section of the thesis will present previous research in gender health inequalities that used SHARE as their data source as it allows for greater comparability across studies, as the dataset is standardized and consistent in its collection method and variables.

A study by Gómez-Costilla et al. (2022) examined gender health gaps measured by self-reported health in older people in 18 European countries. This study draws on the sixth wave of SHARE, for which data collection took place in 2015. The authors found that significant gender differences in health were only observed in Southern and Northern European countries. Specifically, old women reported worse health than men of all ages in Southern countries, while in Northern European countries, this was only true for women aged 80 and over. Western European countries, on the other hand, exhibited barely any gender differences. Moreover, the study found that between the ages of 60 and 79, men from Eastern European countries reported poorer health than women, while after 80, it was women who reported poorer health status. Overall, the study found that the widest gender inequalities in health were observed in the oldest population group, especially in Southern and Eastern European welfare regimes.

Another study by Scheel-Hincke et al. (2020) used a pooled sample of waves 1 to 6 in the SHARE and evaluated gender differences in Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) across different European countries. Similarly, to the Gómez-Costilla et al. (2022) paper, Scheel-Hincke et al. (2020) found that women in Southern European countries had more limitations than men in all age groups with the largest absolute gender difference in health in the age group of 80 years old and above. In contrast, the results of this study showed that in Western and Eastern Europe, absolute sex differences were present at ages 65-79 years and 80 years and above, while in Northern Europe, women had a higher risk of ADL limitations than men, but only in the oldest age group.

Ahrenfeldt et al. (2020) conducted a study to investigate the differences in comorbidity and frailty between men and women across age groups and various countries in Europe. Their study involved the use of a comorbidity index that was based on ten major diseases (heart attack, stroke, lung disease, arthritis, stomach/duodenal ulcer, diabetes, cancer, hypertension, high cholesterol, and Parkinson's) and frailty phenotype. Similar to Scheel-Hincke et al. (2020), the researchers used SHARE waves 1, 2, 4, 5, and 6 to include a larger number of older individuals. Consistent with the findings of Gómez-Costilla et al. (2022), Ahrenfeldt et al. (2020) study observed variations in gender differences in comorbidity across different regions of Europe. Specifically, in Western Europe, no significant difference in comorbidity was found between men and women. However, in Eastern, Southern, and Northern Europe, women exhibited higher comorbidity rates compared to men. Moreover, the study by Ahrenfeldt et al. (2020) corroborated previous research by demonstrating that women tend to be frailer than men across all European regions examined. Notably, the largest disparity between genders in frailty was observed in Southern Europe, indicating that gender differences in frailty are particularly prominent in this region.

Uccheddu et al. (2019) conducted a comparative study to examine whether the relationship between SES and health differs by gender using a 40-item frailty index. The study used SHARE data from nine European countries: Austria, Belgium, Denmark, France, Germany, Italy, Spain, Sweden, and Switzerland. Panel data from the five waves of the SHARE between 2004 and 2015 were analyzed. In contrast to the findings reported by Gómez-Costilla et al. (2022) and Ahrenfeldt et al. (2020), Uccheddu et al. (2019) revealed that in Western European countries, women exhibited a stronger association between education and health compared to men. Whereas in Northern Europe, no gender differences were observed based on SES. It is worth noting that, unlike other studies, this study did not include Eastern European countries and did not stratify their analysis by age.

It is important to highlight that there are a number of studies that utilized European data other than SHARE. Nevertheless, their results are also somewhat mixed. For example, before SHARE, the primary data source available was the European Community Household Panel (ECHP), which provided information on health, social relations, and the socio-economic background of respondents in 14 European Union countries from 1994 to 2001. Huisman et al. (2003) utilized the ECHP data and found that inequalities in self-reported health, limitations in daily activities, and long-term disability were often larger among men in Ireland, the Netherlands, Greece, and Italy, while among women, these inequalities were the largest in Ireland, Greece, and Spain. Additionally, some studies used national accounts to examine gendered health inequalities. Bambra et al. (2009) examined cross-sectional national health surveys from 13 European countries conducted between 1998 and 2004 and discovered that the relationship between gender and self-reported health, stratified by educational rank, varied across countries. In Portugal, Sweden, and Italy, women in the highest educational group exhibited the highest vulnerability to experiencing poor self-reported health, while no clear relationship was observed in Spain, the Netherlands, Norway, and Denmark.

2.2.3 Gaps in existing knowledge

While there have been several studies examining gender health inequalities among older adults in Europe, their findings have been inconsistent, highlighting the need for further research to gain a more comprehensive understanding of the issue. Within the current literature, several gaps can be identified based on country-specific and pan-European studies in Europe. This thesis aims to address these gaps and contribute to the existing body of literature in four significant ways.

Firstly, the choice of health measures in previous studies has varied, leading to inconsistent results. While some studies focused on self-reported health (Gómez-Costilla et al., 2022), others examined Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) (Scheel-Hincke et al., 2020), comorbidity index and frailty phenotype (Ahrenfeldt et al., 2020), or utilized a frailty index (Uccheddu et al., 2019). In this thesis, the frailty index will be used as a health measure, which has not been widely used in the literature. The frailty index has been shown to be a more comprehensive and multidimensional measure of health compared to other measures such as self-reported health or ADL limitations (Romero-Ortuno & Kenny, 2012). By using frailty as a health measure, this research can provide a more nuanced understanding of gender health inequalities among older adults in Europe.

Secondly, the interplay between gender and SES in determining health outcomes has not been explored in depth in all studies. While Uccheddu et al. (2019) study included the interaction between SES and gender, other studies only considered SES as a control variable. This thesis incorporates the intersection of gender and SES to obtain a more nuanced understanding of how gender health disparities are influenced by SES.

Furthermore, there is a lack of clarity regarding how age mediates gender disparities in health across different European countries. While Gómez-Costilla et al. (2022) and Scheel-Hincke et al. (2020) find that disparities become more pronounced with increasing age, particularly in Southern and Eastern European countries, these findings were not stratified by SES. This thesis will examine gender health inequalities across different age groups, starting from the middle to older ages, while considering the interaction with SES. Doing so, it will provide insights into how gender disparities in health evolve with age and how socioeconomic factors may moderate these disparities.

Lastly, the geographical focus of previous studies has been limited and varied. Each of these studies included a slightly different set of countries, making it difficult to compare their results. For instance, Uccheddu et al. (2019) did not include Eastern European countries in their analysis, leaving a gap in understanding how gender health disparities function within this particular geographic region. This thesis will include 17 European countries, including Eastern European countries.

Overall, this thesis aims to make a valuable contribution to the literature on gender health inequalities among older adults in Europe, by employing a comprehensive health measure, considering the intersection of gender and SES, including a wider range of countries, and examining gender disparities across different age groups.

3 Hypothesis

This thesis will test three hypotheses based on theory and previous literature presented in the section above. The first hypothesis is to test if gender inequalities in health differ based on the socioeconomic status among middle and older age men and women across Europe, with higher SES individuals exhibiting better health outcomes than lower SES individuals. The second hypothesis is to explore if the influence of socioeconomic status on gendered health outcomes will vary based on the type of welfare regime in place, with countries with more developed welfare regimes showing a weaker association between SES and health outcomes among women compared to countries with less developed welfare regimes. The final hypothesis is to confirm if there will be differences in the association between socioeconomic status and health outcomes across different age groups, with the strongest association observed among the oldest age group (80+), followed by the 70-79 age group, 60-69 age group, and 50-59 age group.

H1: Middle-aged and older men and women in Europe with higher SES will have lower frailty index scores compared to those with lower SES. The association between SES and frailty index will vary by gender, with a stronger association among men compared to women.

H2: Northern European welfare regime will have a weaker association between SES and frailty index for both men and women than Southern, Eastern, and Western welfare regimes.

H3: The relationship between socioeconomic status and health outcomes will be stronger for older age groups compared to middle age groups with a stronger association among men compared to women.

4 Data

This chapter provides a comprehensive overview of the data that will be utilized to test the research hypotheses. The chapter begins by presenting the data sources, including information on the sample size. Subsequently, the variables used in the study are described in detail, highlighting their creation and measurement.

4.1 Source Material

In this thesis, the data from the Survey of Health, Ageing and Retirement in Europe (SHARE) was utilized. SHARE is the most extensive pan-European social science panel, with over 140,000 participants from 28 European countries and Israel, beginning in 2004 (Börsch-Supan et al., 2013). Its primary objective is to enhance knowledge about the impact of aging on individuals in various contextual settings across Europe. The survey collects data bi-annually, covering health, socioeconomic status, and social and family network-related information. The target population consists of individuals aged 50 and above, who reside in their respective SHARE country, speak the country's language(s), and are not institutionalized. Data collection is conducted through face-to-face computer-assisted personal interviews and a questionnaire (Börsch-Supan et al., 2013).

For this thesis, data from the sixth wave of SHARE conducted in 2015 was used. The sixth wave provides representative and cross-nationally comparable panel data for over 68,000 individuals. It is important to note that the data from this specific wave included information from only 18 European countries, rather than the full set of 28 countries. Following other studies that have examined health inequalities institutionalized individuals and migrants were excluded from the analysis (Gómez-Costilla et al., 2022; Uccheddu et al., 2019). Institutionalized individuals, such as those residing in nursing homes, accounted for 1.68% of the sample, amounting to 1,098 individuals, while migrants accounted for approximately 16.56% of the sample, corresponding to 10,794 individuals. Although the migrant sample appeared similar to

the non-migrant sample in terms of sex and education[1], migrants are a self-selected group and their health outcomes may differ from non-migrants due to factors such as pre-migration health status and reasons for migration, which could impact the study outcomes (Rechel et al., 2013). As the main focus of the analysis did not involve migrants, they were excluded from the study analysis. Additionally, Israel was excluded from the study due to its non-European status. Observations with missing information in education, urban residence status, and weight[2] variables were also removed, resulting in a final sample of 49,764 individuals aged 50 years and above from 17 European countries.

As discussed in the theory and previous research sections, the data from 17 European countries were grouped into four clusters based on their welfare state regimes and geographical location: Northern Europe (Denmark, Sweden), Western Europe (Austria, Germany, France, Switzerland, Belgium, and Luxembourg), Southern Europe (Spain, Italy, Portugal, and Greece), and Central and Eastern Europe (Czech Republic, Poland, Slovenia, Croatia, and Estonia).

4.2 Variables

As highlighted in the theory and previous research section there are various ways in which health inequalities can be measured. Given that this study aims to examine if there are gender differences in health that vary by education after midlife across 17 different European countries, the frailty index was chosen as the main outcome variable. A frailty index is a multidimensional approach to measuring the health of older adults, incorporating various physical frailty indicators such as diagnosed illnesses, self-reported health, weight loss, grip strength, cognitive impairment, mood, and limitations in daily living activities (Romero-Ortuno & Kenny, 2012). Compared to other health measures, the frailty index offers a more comprehensive and objective view of overall health status, capturing a range of physical and mental health impairments, as well as functional limitations. In contrast, chronic conditions and self-reported health measures are limited in scope and are influenced by subjective factors such as individual perception, social desirability bias, and cultural norms (Fried et al., 2001). Furthermore, the frailty index

[1] Among the migrants 47% were men (43% in the non-migrant sample), 39% had low and 40% had medium education (40% and 37% in the non-migrant sample respectively).

[2] Missing observations in education, urban residence status, and weights accounted for 1.39%, 5.27%, and 0.48% of the sample respectively.

offers a standardized and objective assessment of health that can be used to compare health inequalities across different population groups and countries (Mitnitski et al., 2001). This makes it an ideal tool for evaluating gender health inequalities among the elderly in Europe. Additionally, the frailty index has demonstrated superior predictive power for mortality and disability compared to other health measures, further emphasizing its value in assessing health inequalities (Romero-Ortuno & Kenny, 2012).

In this study, the frailty index score was computed using the standard procedures as outlined by Searle et al. (2008). The frailty index is based on counting health deficits which can include signs, diseases, or symptoms. A higher number of deficits indicates greater frailty. All health deficits in the data were recoded as binary variables, with 0 indicating the absence of the deficit and 1 indicating the presence of a deficit. For self-reported health, categories were created with values assigned to each category ("Excellent = 0", "Very Good = 0.25", "Good = 0.5", "Fair = 0.75" and "Poor = 1"), enabling its inclusion in the frailty index calculation. The frailty index was computed as the sum of each individual's deficit points divided by the total number of evaluated deficits (40) to obtain a score ranging from 0 to 1 (Searle et al., 2008; Romero-Ortuno & Kenny, 2012). A frailty index score of 0 indicates the absence of deficits, while a score of 1 indicates the presence of all evaluated deficits. For instance, an individual with five deficits would have a frailty index value of 0.125 (5/40). Detailed information on the variables that were included in the frailty index and cut-off points can be found in Appendix A Table A1.

During the creation of the index, missing values were minimal for each item except for grip strength, which had the highest percentage of missing values at 8.80%. To ensure a comprehensive frailty index, all variables, including those with missing values, were included in the analysis and were treated as 0. In order to evaluate the reliability of the computed frailty index Cronbach's alpha was computed. Cronbach's alpha is a measure of internal consistency, which is used to evaluate how well a set of items measures a single underlying construct or dimension (Cronbach, 1951). In this case, the 40 items are being used to measure a specific aspect of health among the elderly population. A reliability coefficient of 0.8890 was obtained, which suggests that the items are highly interrelated and consistent, indicating that they are measuring the same construct (Mitnitski et al., 2001).

Given that this thesis focuses on analyzing the impact of welfare state regimes on gender inequalities in health among the elderly in Europe and how this changes with age the main independent variables are gender, socioeconomic status (SES), and age. Gender is a crucial variable in the analysis and is incorporated in the models as a binary variable. In order to account for the different patterns of frailty across the age range, individuals' age was categorized into four groups: 50-59, 60-69, 70-79, and 80 and above.

As has been highlighted in the theory and previous research section of this thesis, there is no consensus among researchers on the best variable to employ when analyzing SES (Gómez-Costilla et al., 2022; Lee, 2000; Crimmins et al., 2011). Nevertheless, out of income, wealth, occupation, and education, educational attainment seems most suitable to capture gender health disparities among different countries. In SHARE data education is classified based on the 1997 International Standard Classification of Education (ISCED-97) and will refer to the respondent's highest level of education, categorized as low (ISCED 0, 1, and 2), medium (ISCED 3 and 4), or high (ISCED 5 and 6).

In addition to the three main independent variables, two control variables were added to the models: living with a partner and urban or rural residence. Having a partner is regarded as a type of social capital, believed to enhance overall health and mitigate the likelihood of experiencing depressive symptoms. However, it is important to note that this effect might be different for older women, as they are more likely to take on the role of primary caregivers, and the likelihood of having a partner with disability increases with age (Feld et al., 2006). Therefore, gender-specific effects on the health of older adults may exist, emphasizing the importance of controlling for individuals living with a partner in the analysis. Additionally, urban or rural residence is included as a control variable. Residing in an urban setting provides individuals with greater access to quality health services, while living in underdeveloped rural areas may limit access to such resources due to reduced availability and transportation barriers, which may particularly impact the health of older adults (Gómez-Costilla et al., 2022).

5 Methods

This chapter explains the methodology used in this analysis. This chapter describes the necessity of multilevel modeling and describes the model specification and the use of random intercepts. It also highlights the importance of using calibrated cross-sectional weights to deal with sample attrition and nonresponse.

5.1 Multilevel modeling

In this master thesis, a multilevel linear regression model will be used to analyze the data. Multilevel linear regression also referred to as hierarchical linear regression or mixed-effects regression, is a statistical modeling technique that can analyze data with a nested or hierarchical structure (Snijders & Bosker, 2011). This approach allows for the estimation of relationships between independent and dependent variables while accounting for the fact that observations are not independent but are nested within higher-level units. In this thesis, the data have a two-level structure, where individuals represent level 1 and the 17 European countries represent level 2.

The utilization of multilevel models in this thesis is justified for several reasons (De Leeuw, Meijer, & Goldstein, 2008). Firstly, the data used in this study possess a hierarchical structure, where individuals are nested within countries. This violates the assumption of independence of observations required for standard linear regression. By employing a multilevel approach, this issue of non-independence will be appropriately addressed. Secondly, the research questions aim to understand the variation in health outcomes at both individual and country levels. Therefore, multilevel analysis is suitable for capturing and modeling such variations (Snijders & Bosker, 2011).

In a multilevel linear regression model, the dependent variable is predicted by a set of independent variables at each level of the hierarchy. The model partitions the variation in the dependent variable into two parts: variation at the individual level and variation at the higher-level units (in this case the countries) (De Leeuw, Meijer, & Goldstein, 2008). The model incorporates fixed effects that capture the relationships between the independent variables (SES and gender) and the dependent variable (frailty index). Additionally, the model includes random effects, which are the random intercepts and slopes that account for the variation between the higher-level units (countries). These random effects explain the differences between the higher-level units that are not explained by the fixed effects.

To determine whether the use of a multilevel model is necessary, the intraclass correlation coefficient (ICC) will be computed as a measure of the extent to which between-country differences explain the variation in the outcome variable (Robson & Pevalin, 2015). The ICC

is calculated by dividing the individual between-country variance by the total variance of the outcome, which is the sum of the individual between-country variance and the individual within-group variance.

$$ICC = \frac{\tau^2}{\tau^2 + \delta^2} \quad (1)$$

The resulting ICC ranges from 0 to 1, with higher values indicating a greater necessity for multilevel modeling. It is important to note that even with small ICC values, using simple ordinary least squares (OLS) regressions to analyze hierarchical data may lead to an inflation of type 1 errors, increasing the risk of frequent rejection of null hypotheses (Musca et al., 2011). While some researchers consider any ICC value greater than zero as evidence for hierarchical structures and the need for multilevel modeling, Heck, Thomas, and Tabata (2013) often consider a value of 0.05 as a commonly applied "cut-off" value. In the empirical analysis part of this thesis, the ICC will be calculated and presented in Table 2 as a null model.

5.2 Model specification

As established, a two-level linear regression model is used within this thesis where level 1 is individuals and level 2 is countries. The models include a random intercept term to account for the random variation in the mean frailty index across countries. The equations can be expressed as follows:

$$FI_{ij} = \beta_{0j} + \beta_1 Gender_{ij} + \beta_2 Education_{ij} + \beta_3 (Gender_{ij} * Education_{ij}) + \beta_4 X_{ij} + \varepsilon_{ij} \quad (2)$$

$$\beta_{0j} = \gamma_{00} + u_{0j} \quad (3)$$

where FI is the frailty index for individual i in group j, β_{0j} is the random intercept for group j, and e_{ij} is the residual error for individual i in group j. The level 2 equation provides an estimate of the variation in the intercepts across the different groups, with γ_{00} being the fixed effect coefficient for the intercept across all groups and u_{0j} being the random intercept which indicates the random deviation of group j's intercept from the overall intercept.

To address the first research question, the analysis will be run on the whole sample to see if gender inequalities in health vary by SES. For the second research question, each welfare state will be analyzed separately to see whether the influence of SES on health outcomes varies among men and women based on the type of welfare regime in place. To answer the third research question, the sample will be stratified by welfare state cluster and age group, resulting in 16 separate regressions to assess potential differences across various age groups.

It is important to emphasize that calibrated cross-sectional individual weights provided by SHARE were added to the analysis to ensure the sample's representativeness of the entire population of each country (Börsch-Supan & Jürges, 2005). These weights address the problems related to sample attrition, unit, and item nonresponse. The calibrated cross-sectional weights are computed separately by country to match the size of the national 50+ population of

individuals in the year that the survey takes place, which in this thesis corresponds to 2015 (Börsch-Supan et al., 2013).

6 Empirical Analysis

6.1 Descriptive statistics

Table 1 presents the descriptive statistics of the sample. The mean frailty index score for the entire sample is 0.15, with men scoring marginally lower than women (0.14 and 0.17 respectively). The sample comprises 43.60% male and 56.40% female respondents. The age distribution of the sample is slightly skewed towards older adults, with men having a higher representation in the 60-69 age range (38.50%) than women (36.10%), while women have a higher representation in the 80+ age range (15.30%) than men (14.70%).

Table 1. Descriptive statistics

Variable	Whole Sample (N = 49,764) % Mean	Men (N = 21,825) % Mean	Women (N = 27,939) % Mean
Frailty Index (FI)	0.15	0.14	0.17
Gender			
Male	43.80%		
Female	56.20%		
Education			
Low	40.30%	36.40%	43.30%
Medium	38.00%	39.40%	36.90%
high	21.70%	24.10%	19.80%
Age			
50-59	19.70%	17.60%	21.40%
60-69	37.30%	38.40%	36.40%
70-79	28.00%	29.30%	26.90%
80+	15.00%	14.70%	15.30%
Urban	65.90%	65.20%	66.40%
Living with a partner	72.60%	82.80%	64.70%
Welfare state			
Northern Europe	13.30%	14.00%	12.80%
Western Europe	37.00%	37.80%	36.40%
Southern Europe	23.80%	24.20%	23.40%
Eastern Europe	25.90%	23.90%	27.40%

Note: Weighted using calibrated individual cross-sectional weights.

The educational attainment levels indicate gender disparities, with women having a higher representation (43.50%) in the low education category than men (36.50%). In contrast, men have a higher representation (24.20%) in the high education category than women (19.90%). Table 1 also reveals a gender difference in living arrangements, with men more likely to cohabit with a partner (82.04%) than women (63.56%). Moreover, it was seen that 65.90% of the total sample, 65.20% of men and 66.40% of women lived in urban areas. The sample is predominantly from Western Europe (36.20%), followed by Eastern Europe (26.50%), Southern Europe (24.20%), and Northern Europe (13.20%).

Figure 1 presents a detailed breakdown of the distribution of the frailty index according to gender and welfare state. The results reveal that the frailty index is most prominent in Eastern European countries for both genders, with a frailty index of 0.17 for men and 0.21 for women, whereas the Northern European countries have the lowest frailty index, with a score of 0.10 for men and 0.13 for women. The frailty index in Western countries is similar to that of Northern European countries, with a score of 0.13 for men and 0.16 for women. Although the frailty index is highest among individuals in Eastern European countries, the largest gender gap in frailty is observed in Southern Europe, where men have a frailty index of 0.13 and women have a frailty index of 0.19.

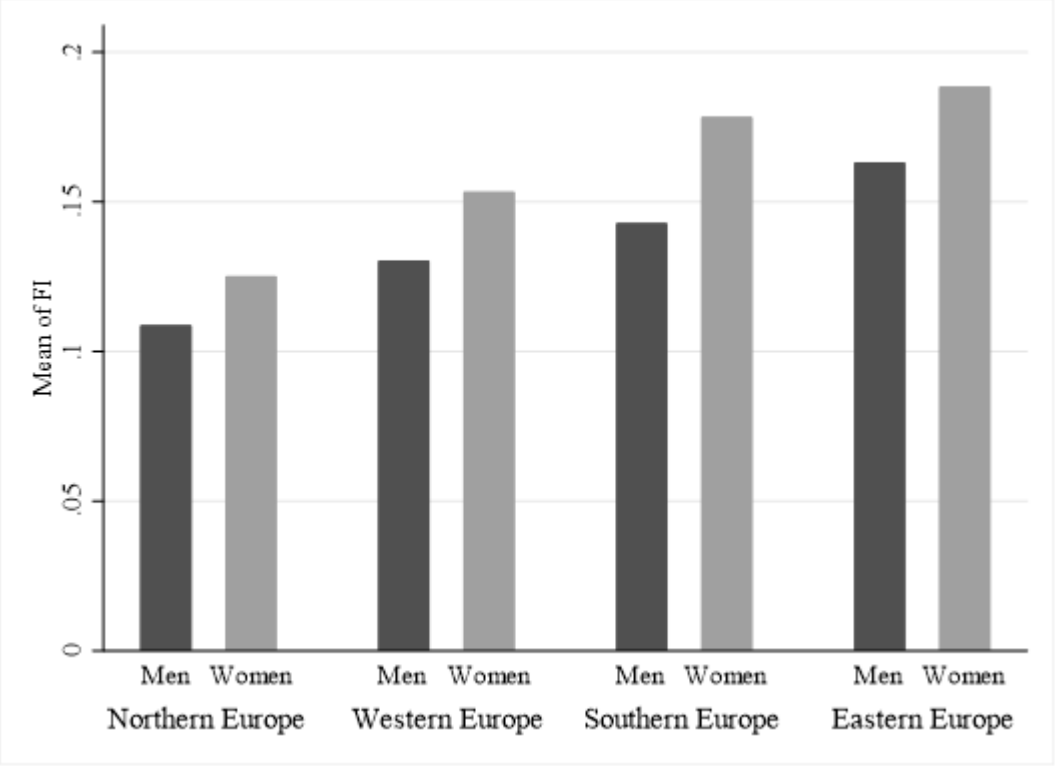

Figure 1. Frailty index according to gender and welfare state

Gender health disparities are most prominent among individuals with low educational attainment in all welfare state clusters (Figure 2). The largest disparities are observed in Southern European countries, where the gender frailty index differences reach 0.0429. The differences are slightly lower in Eastern European countries (0.0345), Western European countries (0.0339), and the smallest in Northern European countries (0.0285).

While low educational attainment is associated with the highest frailty index scores among both genders in all welfare state clusters, the results become less clear for medium and high educational attainment. For individuals with medium educational attainment, the overall frailty index scores are highest in Eastern European countries. Interestingly, the largest gender gap in frailty scores among individuals with medium educational attainment is observed in Northern Europe, with a difference of 0.018. In contrast, the gender gap in frailty index scores is smallest in Southern Europe, with a difference of 0.007. Similarly, among individuals with high educational attainment, the largest gender health disparities are observed in Eastern European welfare states, with a difference of 0.011 in frailty scores. On the other hand, the smallest difference in gender health disparities is observed in Southern Europe, with a difference of 0.004 among individuals with high educational attainment.

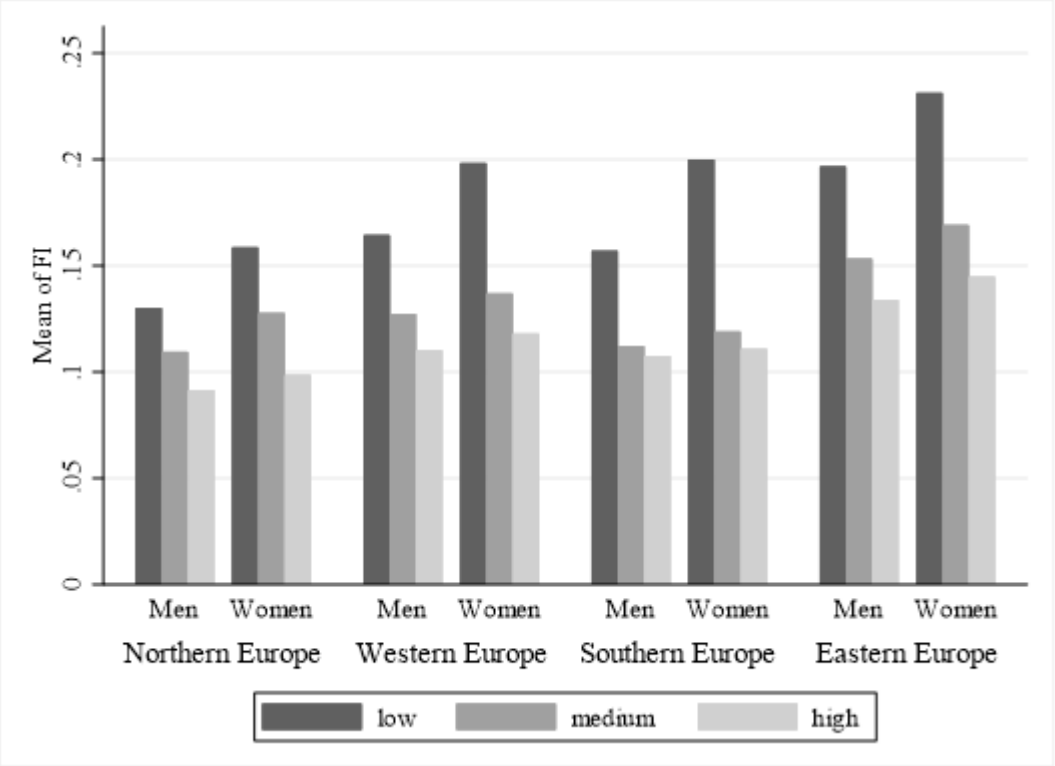

Figure 2. Frailty index according to gender, education, and welfare state

According to Figure 3, the frailty index increases with age for both women and men across all four welfare state clusters. These findings align with the descriptive results presented in Figure 2 and highlight that gender health disparities are most pronounced among individuals with low education, irrespective of age. Specifically, in the Southern European countries, the gender health gap for individuals with low educational attainment is 0.0255 in the youngest age group, 0.0317 in the 60-69 age group, 0.0479 in the 70-79 age group, and 0.0763 in the 80+ age group. In comparison, for individuals with high educational attainment in the same age groups, the gender health disparities are 0.012, 0.017, 0.0143, and 0.0191, respectively. However, in Northern European countries, the impact of education on gender health differences is less pronounced. In these countries, the gender health difference between low and high educated individuals in the oldest age group is 0.018. In contrast, Southern European countries exhibit a

difference of 0.057, Eastern European countries show a difference of 0.0292, and Western European countries demonstrate a difference of 0.0352 for the same age group.

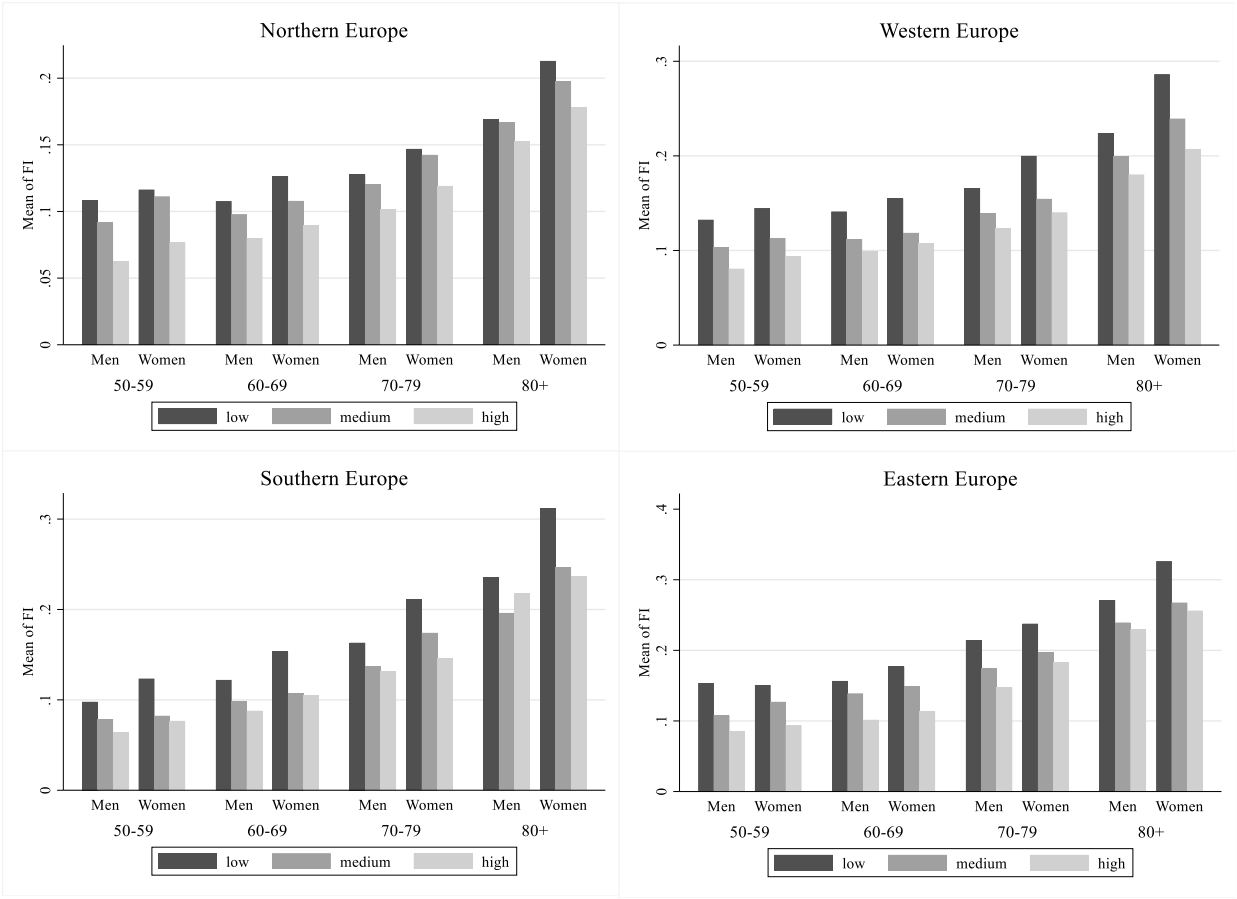

Figure 3. Frailty index according to gender, education, and age category stratified by welfare state cluster

6.2 Regression results

6.2.1 Effects in the entire sample

Table 2 reports the results of the main five multilevel linear regression models, with the dependent variable being the frailty index. The first model is a null model that includes solely the initial estimation of the frailty index variance at the country level. Model 2 then adds the gender and age variables and Model 3 incorporates the level of education. In Model 4, the full set of controls (living with a partner and in an urban area) is added to the model. Finally, Model 5 reports interaction effects between gender and level of education. These models were executed on a sample of 49,764 individuals nested within 17 European countries.

The null model (Model 1) is used to assess whether multilevel modeling is necessary. The country-level intra-class correlation (ICC) equals 0.05, which is equal to the threshold of 0.05, indicating the need for multilevel modeling (Heck, Thomas & Tabata, 2013). Model 2

demonstrates a substantial gender gap and a positive age gradient. The coefficient for gender suggests that on average women have a 0.026 higher frailty index compared to men. The coefficients for the age categories show that older age groups have higher frailty index values compared to the reference group (50-59 years old). The effect increases with age, for instance in comparison to the reference age group individuals between 60 and 69 have a 0.0196 higher frailty index, however, individuals older than 80 have a 0.151 higher frailty score. The effects observed in the analysis are statistically significant. Model 3 results show that medium and high education levels are associated with lower frailty scores compared to low educational attainment, with coefficients of 0.0295 and 0.0510, respectively. The effects of gender, age, and education persist even after the inclusion of additional covariates in Model 4. Living with a partner significantly decreases the frailty index, whereas living in an urban area does not have a significant effect on the frailty index score.

Model 5, the final model, incorporates all covariates and includes an interaction term between gender and level of education. The coefficient for gender in this model is 0.0338, which is statistically significant. This means that, while holding all other variables constant, women with low education have a frailty index that is, on average, 0.0338 points higher than that of men. Examining the effect of education, it can be observed that compared to individuals with low education, men with medium education have a statistically significant 0.0164 lower frailty index score, while men with high education have a statistically significant 0.0363 lower frailty index score. The interaction term between gender and education is also statistically significant, indicating that gender differences in health vary by education. For women, the interaction terms for medium and high education are both negative and significant. The coefficients for women with medium and high education are -0.0215 and -0.0252, respectively. This suggests that the protective effect of education on frailty is even more pronounced for women. These results indicate that while both men and women with higher education levels have lower frailty index scores, the reduction in frailty index is more substantial for women. Nevertheless, women with medium education have a 0.0123 higher frailty index than men with medium education, whereas women with high education have a 0.0086 higher frailty index than men with high education. These findings align with the patterns observed in Figure 2, where the gender differences in frailty index are most significant among individuals with low educational attainment, whilst the disparities between men and women with medium and high education are smaller.

The Akaike information criterion (AIC) is used to assess how well the estimated statistical models fit the data. A lower AIC value indicates a better fit, as it suggests that the model is better able to explain the variability in the data. In this study, all the tested models exhibited improvements over the null model, which serves as a baseline by assuming no relationships between the variables. However, Model 5 demonstrated the lowest AIC score, indicating that it is the best-fitting model among the tested alternatives. The finding that Model 5 achieved the lowest AIC score provides additional support for the importance of considering education on gender differences. This reinforces the notion that education effects need to be taken into account when studying the relationship between gender and frailty. Therefore, Model 5 is deemed the most appropriate and reliable model for further analysis in this study. Additionally, Table 2 presents information on the variation between countries, as well as the individual and country-level percentages of the total variance. According to Model 5, the frailty index significantly varies across the 17 countries included in the analysis (0.00056), with 4.42% of

the total variance attributable to differences between countries. This suggests that there are country-specific factors influencing frailty outcomes, highlighting the importance of considering the contextual factors associated with each country in understanding and addressing frailty disparities.

Table 2. Multilevel regression analyses of frailty index

	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	0.154***	0.0939***	0.121***	0.138***	0.130***
	(0.0071)	(0.0060)	(0.0078)	(0.0062)	(0.0057)
Gender (ref.: Men)					
Women		0.0263***	0.0238***	0.0197***	0.0338***
		(0.0029)	(0.0033)	(0.0031)	(0.0045)
Age (ref.: 50-59)					
Age 60-69		0.0197***	0.0179***	0.0173***	0.0171***
		(0.0034)	(0.0033)	(0.0032)	(0.0031)
Age 70-79		0.0649***	0.0590***	0.0567***	0.0562***
		(0.0058)	(0.0056)	(0.0053)	(0.0053)
Age 80+		0.151***	0.140***	0.133***	0.132***
		(0.0098)	(0.0099)	(0.0095)	(0.0094)
Level of Education (ref.: Low)					
Medium			-0.0295***	-0.0288***	-0.0164***
			(0.0026)	(0.0028)	(0.0036)
High			-0.0510***	-0.0502***	-0.0363***
			(0.0042)	(0.0045)	(0.0051)
*Interaction: Gender * Level of education*					
Women * Medium					-0.0215***
					(0.0045)
Women * High					-0.0252***
					(0.0051)
Urban				-0.000263	-0.0000239
				(0.0031)	(0.0031)
Living with spouse/partner				-0.0210***	-0.0206***
				(0.0019)	(0.0018)
AIC	68,729	68,606	68,252	66,955	66,658
Country ICC	0.05	0.05	0.05	0.04	0.04
Between country variation	0.00079	0.00070	0.00057	0.00056	0.00056
Individual level percentage of total variance	95.09%	94.71%	95.50%	95.57%	95.58%
Country level percentage of total variance	4.91%	5.29%	4.50%	4.43%	4.42%
Observations	49,764	49,764	49,764	49,764	49,764
Number of groups	17	17	17	17	17

Note: Weighted using calibrated individual cross-sectional weights.
Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

6.2.2 Effects stratified by welfare regime

Table 3 presents the findings from the multilevel linear regression models, which were estimated separately for each welfare state cluster. These results shed light on the varying influence of socioeconomic status on gendered health outcomes across different types of welfare state regimes. The coefficient for gender is found to be statistically significant in all four welfare state clusters, indicating that women with low educational attainment have significantly higher frailty index scores compared to men with the same level of education. When comparing the size of the coefficients, it becomes evident that the effect of gender is strongest in Southern European countries, where the coefficient is estimated to be 0.0434. In the other three welfare state clusters, the size of the coefficients is smaller and relatively similar. Additionally, across all welfare state clusters, a negative association between education and the frailty index is observed. This means that higher levels of education are associated with lower frailty index scores, regardless of the welfare state cluster being examined.

Furthermore, Table 3 highlights that the effect of education is stronger for women than for men in Western, Southern, and Eastern European countries, as indicated by the statistically significant effect. For instance, in Southern European countries, women with medium education have a frailty index that is 0.0196 higher than men with medium education. However, for women with high education, the difference in frailty index compared to men is only 0.0032. Similar patterns are observed in Western European countries, where the frailty index for women with medium education is 0.0112 higher than that of men with medium education, and for women with high education, the effect is 0.0069. These results indicate that even though women with higher education still have higher frailty levels than men with the same education level, the gap is smaller than it is for women with lower education levels in these welfare state clusters. On the other hand, the results indicate that in Northern European countries, gender differences in frailty do not vary by education. Although women with low education still exhibit statistically significantly higher frailty index scores compared to men with the same level of education, there are no statistically significant differences between men and women with medium and high education levels. This suggests that in Northern European countries, higher education levels mitigate gender disparities in frailty, leveling the playing field between men and women in terms of health outcomes.

Table 3. Multilevel regression analyses of frailty index by welfare state regime

	Northern Europe	Western Europe	Southern Europe	Eastern Europe
Constant	0.114***	0.131***	0.109***	0.154***
	(0.0101)	(0.0048)	(0.0102)	(0.0065)
Gender (ref.: Men)				
Women	0.0209***	0.0289***	0.0434***	0.0223***
	(0.0018)	(0.0058)	(0.0085)	(0.0066)
Level of Education (ref.: Low)				
Medium	-0.00825***	-0.0179***	-0.0164**	-0.0329***
	(0.0001)	(0.0040)	(0.0071)	(0.0034)
High	-0.0280***	-0.0389***	-0.0216***	-0.0637***
	(0.0047)	(0.0067)	(0.0070)	(0.0050)
*Interaction: Gender * Level of education*				
Women * Medium	-0.00173	-0.0177***	-0.0238**	-0.0106***
	(0.0106)	(0.0056)	(0.0107)	(0.0028)
Women * High	-0.012	-0.0220***	-0.0402***	-0.00734
	(0.0101)	(0.0036)	(0.0073)	(0.0096)
Age (ref.: 50-59)				
Age 60-69	0.00985***	0.0126***	0.0325***	0.0149***
	(0.0013)	(0.0020)	(0.0018)	(0.0026)
Age 70-79	0.0331***	0.0453***	0.0805***	0.0643***
	(0.0035)	(0.0049)	(0.0033)	(0.0071)
Age 80+	0.0827***	0.117***	0.171***	0.139***
	(0.0004)	(0.0112)	(0.0093)	(0.0050)
Urban	-0.000364	-0.000292	-0.00287	0.00867
	(0.0055)	(0.0040)	(0.0065)	(0.0057)
Living with spouse/partner	-0.0220***	-0.0198***	-0.0256***	-0.0142***
	(0.0064)	(0.0023)	(0.0032)	(0.0017)
Observations	6,642	18,419	11,825	12,878
Number of groups	2	6	4	5

Note: Weighted using calibrated individual cross-sectional weights.
Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

6.2.3 Effects stratified by welfare regime and age group

To analyze the influence of socioeconomic status on health outcomes among middle and older age men and women across Europe by age, the analysis was stratified by age group. Results in Table 4 show that after stratifying the analysis by the welfare state and age, diverse patterns of health inequalities are discovered among individuals. In Western Europe, women with low education had higher frailty index scores than men in all age groups, with the largest gender difference in the age group 80+ years (coefficient= 0.0497). In Northern European countries

statistically significant gender differences in frailty were present at all age groups apart from 70-79. In Southern Europe, statistically significant gender health differences were present at ages 60-69, 70-79, and 80+. For Eastern Europe, women had higher frailty scores than men in all age groups apart from the youngest. Surprisingly, in the age group 50-59 the gender health gap was negative, meaning that low-educated men had on average 0.013 higher frailty scores than women, however, this coefficient is not statistically significant.

Furthermore, the findings from Table 4 reveal that gender differences in frailty index widen with age across all welfare state regimes which is in line with the descriptive results of Figure 3. Specifically, in Western European countries, the coefficient for the youngest age group (50-59) is 0.0194. This difference decreases to 0.0146 for the 60-69 age group and then increases to 0.0344 for the 70-79 age group, and 0.0497 for those aged 80 and above. In Southern European countries, the coefficient for the 60-69 age group is 0.0313, demonstrating a larger gender disparity in frailty index scores compared to Western European countries. This difference further increases to 0.0437 for the 70-79 age group and 0.0801 for individuals aged 80 and above. Similarly, in Eastern European countries, the coefficient values for the same age groups (60-69, 70-79, and 80+) are 0.0192, 0.0277, and 0.0530, respectively. In Northern European countries, the coefficient for the 50-59 age group is 0.0163, while for the 60-69 age group it is 0.0201. The largest gender disparity is observed for the 80+ age group, with a coefficient of 0.0371.

To further support these findings, an examination of the potential effect modification of gender with respect to the links between socioeconomic status and frailty was conducted by incorporating gender and SES interaction terms. The results indicated a statistically significant and clear educational gradient in frailty in three welfare clusters (Western, Southern, and Eastern). The interaction terms coefficients for women with medium and high education are negative and significant. Consistent with expectations, the educational gradient appeared to be strongest for women living in Southern European countries, less potent in Western and Eastern European countries, and the smallest and non-statistically significant in Northern European countries. In Western European countries, women with medium education have a 0.0234 higher frailty than men with medium education in the 80+ age group, the frailty is 0.0133 higher in the 70-79 and 0.005 in the 60-69 age group. The results for the Eastern European countries are similar, women with medium education have a 0.0178 higher frailty than men with the same education level in the oldest age group, 0.0175 in the 70-79 and 0.0049 in the 60-69 age group. Whereas in Southern Europe women with medium education have a 0.0421 higher frailty index than men with medium education in the oldest age group, 0.04926 in the 70-79 age group, and 0.0003 in the 60-69 age group. This implies that older women in Southern European countries experience at least two more health deficits in the 40-item frailty index compared to men with the same level of education. Interestingly, the results indicate that in the Southern European countries in the highest education group, the effect is reversed in the age groups 70-79 and 80+. Women with higher education would have 0.0069 and 0.0091 lower frailty index than men with the same education level for the 80+ and 70-79 age groups respectively.

Table 4. Multilevel regression analyses of frailty index by welfare state regime and age group

	Northern Europe				Western Europe				Southern Europe				Eastern Europe			
	Age 50-59	Age 60-69	Age 70-79	Age 80+	Age 50-59	Age 60-69	Age 70-79	Age 80+	Age 50-59	Age 60-69	Age 70-79	Age 80+	Age 50-59	Age 60-69	Age 70-79	Age 80+
Constant	0.122***	0.128***	0.148***	0.177***	0.126***	0.149***	0.173***	0.242***	0.123***	0.135***	0.187***	0.265***	0.171***	0.163***	0.219***	0.287***
	(0.0053)	(0.0269)	(0.0029)	(0.0001)	(0.0054)	(0.0053)	(0.0139)	(0.0194)	(0.0084)	(0.0112)	(0.0196)	(0.0140)	(0.0245)	(0.0062)	(0.0158)	(0.0121)
Gender (ref.: Men)																
Women	0.0163*	0.0201*	0.015	0.0371***	0.0194*	0.0146**	0.0344***	0.0497***	0.0289	0.0313***	0.0437***	0.0801***	-0.013	0.0192**	0.0277***	0.0530***
	(0.0091)	(0.0103)	(0.0113)	(0.0009)	(0.0100)	(0.0063)	(0.0127)	(0.0089)	(0.0194)	(0.0072)	(0.0054)	(0.0184)	(0.0128)	(0.0096)	(0.0049)	(0.0143)
Level of Education (ref.: Low)																
Medium	-0.0150***	-0.00964	-0.00941	-0.0011	-0.0214***	-0.0245***	-0.0131	-0.0097	-0.0213*	-0.0152*	-0.0238***	-0.0304	-0.0653***	-0.0172**	-0.0313*	-0.0163***
	(0.0017)	(0.0165)	(0.0173)	(0.0108)	(0.0073)	(0.0042)	(0.0110)	(0.0085)	(0.0115)	(0.0083)	(0.0037)	(0.0190)	(0.0120)	(0.0077)	(0.0160)	(0.0037)
High	-0.0407***	-0.0273*	-0.0261***	-0.0186**	-0.0411***	-0.0420***	-0.0356***	-0.0459***	-0.0271***	-0.0312***	-0.0234*	0.00133	-0.0913***	-0.0539***	-0.0650***	-0.0244*
	(0.0041)	(0.0146)	(0.0021)	(0.0083)	(0.0071)	(0.0050)	(0.0087)	(0.0159)	(0.0063)	(0.0114)	(0.0141)	(0.0064)	(0.0177)	(0.0095)	(0.0084)	(0.0126)
*Interaction: Gender * Level of education*																
Women * Medium	0.00673	-0.0105	0.00685	-0.0151	-0.00829	-0.00906*	-0.0211*	-0.0263***	-0.0157	-0.0310***	0.00556	-0.0380**	0.0293*	-0.0143**	-0.0102	-0.0352***
	(0.0241)	(0.0100)	(0.0251)	(0.0114)	(0.0110)	(0.0053)	(0.0109)	(0.0094)	(0.0310)	(0.0113)	(0.0137)	(0.0178)	(0.0163)	(0.0067)	(0.0104)	(0.0058)
Women * High	-0.00724	-0.0147	-0.00489	-0.0113	-0.0118*	-0.00931***	-0.0272***	-0.0372**	-0.0299**	-0.0178**	-0.0528***	-0.0870***	0.0174	-0.00881	0.00700*	-0.0320*
	(0.0123)	(0.0041)	(0.0200)	(0.0376)	(0.0068)	(0.0033)	(0.0059)	(0.0148)	(0.0151)	(0.0072)	(0.0166)	(0.0266)	(0.0179)	(0.0164)	(0.0040)	(0.0193)
Urban	0.00446	-0.00296	-0.00129	0.00805	0.00882	0.00187	-0.0057	-0.00882	-0.0066	-0.00214	-0.00131	-0.00289	0.0238*	0.00322	0.00443	-0.00933
	(0.0037)	(0.0043)	(0.0019)	(0.0151)	(0.0058)	(0.0042)	(0.0063)	(0.0059)	(0.0105)	(0.0018)	(0.0134)	(0.0081)	(0.0141)	(0.0040)	(0.0063)	(0.0103)
Living with spouse/partner	-0.0237***	-0.0205	-0.0225***	-0.0188**	-0.0150***	-0.0171***	-0.0157***	-0.0295***	-0.0242***	-0.0113***	-0.0245***	-0.0287**	-0.0190**	-0.0135***	-0.00542	-0.0224***
	(0.0017)	(0.0133)	(0.0020)	(0.0078)	(0.0017)	(0.0021)	(0.0030)	(0.0081)	(0.0021)	(0.0036)	(0.0018)	(0.0118)	(0.0084)	(0.0043)	(0.0044)	(0.0050)
Observations	1,238	2,485	1,972	947	4,197	6,841	4,834	2,547	2,078	4,298	3,372	2,077	2,183	4,972	3,780	1,943
Number of groups	2	2	2	2	6	6	6	6	4	4	4	4	5	5	5	5

Note: Weighted using calibrated individual cross-sectional weights.

Robust standard errors in parentheses

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

6.3 Robustness checks

As previously discussed in this thesis, socioeconomic status can be measured using various indicators such as income, education, wealth, and occupation. In this study, education was chosen as the main measure of SES. However, it is important to acknowledge that educational attainment among older individuals may be skewed due to lower average education levels (Huisman et al., 2003). To address this issue, a sensitivity analysis was conducted where household net income was used as an alternative measure of SES. In SHARE data income is collected at a household level, therefore for the sensitivity analysis, quartiles of income were estimated at the household level and adjusted for family size by dividing the income variable by the square root of household size. Appendix B presents the results using income as a measure of SES. The findings from Table B1 in Appendix B support the conclusions drawn from Table 4, indicating that gender differences in the frailty index widen with age across all welfare state regimes. Additionally, similar to the results in Table 4, it was observed that women with low education had statistically significantly higher frailty index scores compared to men in the oldest age group across all four welfare clusters. When examining the results of an interaction between gender and education, the results indicate that it was statistically significant for the youngest age group in Northern European countries. This is in contrast to the findings in Table 4, where no significant interaction was found between education and gender. In Western European countries, a negative and significant effect was observed for the oldest age group, while in both Southern and Eastern European countries, the interaction was not statistically significant for the oldest age group. This suggests that gender differences do not vary by income in Eastern and Southern European countries for the oldest age group. These results partially align with the findings in Table 4, where the negative and significant effect was observed across more age groups. It is worth noting that the nature of the SHARE data, with income measured at the household level, may contribute to these results. It is possible that income may not fully capture gender differences in the frailty index.

To further examine the robustness of the main results, additional regressions were conducted using different age thresholds. In the main study, age groups were divided into four categories: 50-59, 60-69, 70-79, and 80+. To explore the sensitivity of the results to different age categorizations based on life stages, the age groups were redefined as follows: 50-64, 65-74, 75-84, and 85+. The rationale behind this categorization is that 50-64 is considered the pre-retirement stage in most countries, 65-74 is early retirement, 75-84 is late retirement, and 85+ represents the oldest age group (Scheel-Hincke et al., 2020). Appendix C presents the results of the multilevel linear regressions using different age categories than those presented in Table 4. The results revealed that the interaction between gender and education was statistically significant for the oldest age group (85+ years old) in all four welfare state clusters. This finding contrasts with Table 4, where no significant interaction was found for Northern European countries. However, when comparing the magnitude of the effect, the differences were minimal. For instance, in Western European countries, women with medium education had a 0.0253 higher frailty index than men with medium education in the 85+ age group, while in the 80+ age group, the difference was 0.0234 (as reported in Table 4). The results were also similar when comparing the youngest age group. The findings presented in Table C1 of Appendix C

support the main conclusions, confirming that gender differences in frailty index increase with age across different welfare state regimes. Additionally, the findings regarding the influence of education on gender differences in frailty remain consistent across different age groups, providing further evidence of the robustness of the study's findings.

7 Discussion

7.1 Effects in the entire sample

The aim of this study was to examine if there are gender and socioeconomic status differences in health among middle- and old-aged men and women in 17 European countries. The results of this study indicate that on average, women have a higher frailty index than men, indicating poorer health outcomes. Additionally, the finding demonstrates that as educational level increases, the frailty index decreases, suggesting a beneficial effect of higher education on health. Furthermore, the study found significant differences in gendered health outcomes related to education. Specifically, the relationship between education and health is found to be stronger for women compared to men. The interaction between gender and education shows that while both men and women with higher education levels have lower frailty index scores, the reduction in frailty index is more pronounced for women. The results support hypothesis H1 which posited that middle-aged and older men and women with higher SES would have lower frailty index scores compared to those with lower SES, with a stronger association observed among men compared to women.

These results align with existing theory that suggests that women may be more sensitive to the impact of social determinants of health, such as education (Rueda, 2012; Ahrenfeldt & Möller, 2021). It is acknowledged that socioeconomic status plays a crucial role in shaping health outcomes by providing individuals with essential resources, including financial, informational, and social capital, which are vital for managing health conditions and coping with stressors (Phelan et al., 2010; Read & Gorman, 2010). This implies that women, who generally have lower SES levels compared to men, may face significant barriers in accessing health-related resources and services, which could lead to worse health outcomes. This may be attributed to the fact that women have fewer alternative resources, such as power, earnings, and authority, compared to men (McDonough & Walters, 2001; Östlin, 2002). Consequently, women rely more heavily on education as a means to achieve better health outcomes.

7.2 Effects stratified by welfare regime

Turning to the second research question, this thesis tried to evaluate if the influence of socioeconomic status on gendered health outcomes varies based on the type of welfare regime in place. The results indicate that education as a predictor of health in later life does not have the same impact across gender between different welfare states. These findings align with the constrained choice theory, which suggests that macro-level influences shape individual health

outcomes. From this perspective, it is apparent that the structure of different welfare state regimes significantly affects health disparities across gender and educational lines.

Starting with Southern European countries, the results are in line with the previous studies on several health traits such as self-rated health, frailty, and comorbidity that suggest that gender differences in health are widest in this welfare regime (Gómez-Costilla et al., 2022; Uccheddu et al., 2019; Ahrenfeldt et al., 2020). There are several factors that may explain the poorer health outcomes observed among middle-aged and elderly individuals in Southern European countries. One contributing factor is the traditionally lower labor force participation of women, particularly those aged 55 and over, as well as the prevalence of unpaid female family labor. The presence of occupational segregation in the labor market negatively affects women and contributes to lower wages (Garcia-Prieto & Gómez-Costilla, 2017). Consequently, older women residing in Southern Europe may rely more on the general pension system for financial support compared to individuals in welfare regimes found in Northern and Western European countries. Another factor is the greater emphasis on traditions and stronger family support in these countries compared to other welfare regimes (Ferrera, 1996). As a result, fewer elderly individuals in these countries reside in nursing homes and care for dependent partners is often provided at home. However, this may lead to an overrepresentation of older individuals with poor health in this study as it focuses only on the non-institutionalized population.

The Northern European countries showed the smallest gender disparities, especially among individuals with medium and higher educational attainment this study did not observe any gender differences. This supports Esping-Andersen's (1990, 1999) idea of higher defamilization and decommodification in the Nordic welfare state regime. Higher education, which might enable better job opportunities and hence a lessening reliance on the market and family for welfare, seems to help mitigate gender disparities in frailty (Bambra, 2004, 2007). Another possible explanation is that in the Northern European countries, the state offers more generous welfare policies which offer better protection against the health effects of low socioeconomic status (Bambra, 2005).

In contrast to the previous literature (Gómez-Costilla et al., 2022; Ahrenfeldt et al., 2020), this study finds significant gender health differences based on education in Western European countries. One of the potential explanations is that in contrast to the Gómez-Costilla et al. (2022) study that used self-reported health as a health measure, the use of the frailty index was able to capture the health differences between men and women better. Another potential explanation for why significant gender health differences might be present in Western European countries is that even though their pension systems are generous, it is an earning-related type meaning that it benefits men and their health more as they are typically earning more than women (Schuldi, 2005).

Eastern European countries present an interesting case, with gender health inequalities present among individuals with low and medium education, while no statistically significant difference was found among those with high education. This result may be explained by the unique social and historical contexts of these countries, particularly their transition from a universal social protection system to a more differentiated model (Deacon, 2000). As a result, the higher frailty scores among individuals with low and medium education could reflect the significant changes in social welfare provision that occurred during the transition period.

7.3 Effects stratified by welfare regime and age group

The third research question in this thesis aimed to investigate whether the influence of SES on gendered health outcomes differs among different age groups and welfare state clusters in Europe. The study found that gender disparities in frailty increased with age in all welfare state regimes. The higher frailty index scores for women of low education as compared to men with the same education level, especially in Southern Europe, indicate that early-life disadvantages (low SES) result in subsequent risks and disadvantages (higher frailty) as individuals age. This finding aligns with the cumulative disadvantage hypothesis, which predicts that health disparities would grow larger between middle and late life. The interaction terms' results reinforce this finding, indicating the protective effect of education on frailty, more pronounced for women, and revealing that health inequalities seem to be deeply intertwined with both gender and SES. However, when looking at the interaction between gender and education in Northern European countries, there was no significant effect found, indicating that this highly protective welfare state was successful in reducing gender, SES, and age-related inequalities in health among all age groups.

Similarly, to previous studies (Gómez-Costilla et al.; 2022; Scheel-Hincke et al., 2020), this thesis did not identify a consistent pattern between health and age across various welfare states. In the context of Eastern European countries, significant gender disparities in frailty among highly educated individuals were observed only in the 70-79 and 80+ age groups. Additionally, although not statistically significant, the coefficient for the individuals in the 50-59 age group was higher compared to the 70-79 age group. These trends can potentially be explained by the significant transformations that Eastern European countries have undergone in the past few decades, such as transitioning from socialism to a market economy and adopting democratic governance. These changes may have influenced the health outcomes of different age and education groups in different ways. For example, older individuals who experienced the socialist era may have had different health outcomes than younger individuals who lived in a more market-driven economy (Deacon, 2000).

Interestingly, the results indicate that in the Southern European countries in the highest education group, the effect is reversed in the age groups 70-79 and 80+, with older women having a lower frailty index than men. One potential explanation for the reversed effect in Southern European countries for highly educated women in the oldest age groups could be related to gender differences in life expectancy. In these countries, women tend to live longer than men, and as a result, there is a larger proportion of women in the oldest age groups. This means that women who have survived to these ages may be a select group of particularly resilient individuals, which could explain why they have lower frailty scores despite their age (Read & Gorman, 2010). However, further research is needed to fully understand the mechanisms behind this reversed effect.

8 Conclusions

This thesis was aimed at investigating how SES, gender, and health intersect and develop in later life. More specifically, to examine if there are gender differences in frailty index that vary by education among middle-aged and older individuals across 17 different European countries. The existing literature lacks a systematic examination of gender health inequalities across European countries in relation to their welfare regimes and across different age groups. Therefore, this study contributes to the existing body of literature by examining the link between education (a proxy for SES) and the frailty index. Additionally, this study sheds light on how gender disparities in health vary by SES, considering the influence of different welfare regimes. Furthermore, by examining gender health inequalities across different age groups, the study assesses whether health inequalities decrease, remain stable, or increase with age. This association was tested using the sixth wave of SHARE data and estimating two-level linear regression models in different European welfare clusters (Northern, Western, Southern, and Eastern) and among different age groups (50-59, 60-69, 70-79, and 80+).

The findings of this study reveal several important insights. Firstly, women have higher frailty index scores than men on average. Additionally, the results show a clear relationship between education and frailty index, with higher education levels associated with lower frailty index scores, indicating a positive impact of education on health. Notably, the study finds that the protective effect of education on the frailty index is stronger for women than for men. While both genders benefit from higher education levels in terms of lower frailty index scores, the reduction in frailty index is more pronounced among women. This underscores the potential for education to have a greater impact on reducing health deficits for women in later life. Furthermore, the findings demonstrate that the influence of education on health is more prominent for women than for men in Southern, Western, and Eastern European countries. However, in Northern Europe, no substantial gender disparity in health outcomes based on SES was observed. This suggests variations in the relationship between SES and health across different regions of Europe, emphasizing the importance of considering the contextual factors of welfare state regimes when examining gender health disparities. Lastly, the study highlights an age-related gradient in gender disparities in frailty. Gender health inequalities were significant among low-educated individuals aged 80 years regardless of the welfare state. However, for medium and higher education, significant gender differences in frailty were only observed in Southern, Western, and Eastern welfare state clusters.

The study's findings highlight the importance of taking into account the complex interaction between gender, education, health, and welfare regimes when devising policies and interventions to enhance the health of older populations. The stronger protective effect of education on the frailty index for women compared to men suggests that initiatives promoting education among women can play a crucial role in reducing health disparities in this group. Additionally, the study's findings of widening gender disparities in frailty with advancing age emphasize the necessity of targeted interventions tailored to the specific health needs of older

individuals. To address these findings, policymakers and healthcare providers should prioritize the development of comprehensive and multidimensional health programs that cater to the unique requirements of older individuals. This is particularly important for Southern, Western, and Eastern European countries, where the age-related gradient in frailty was observed to be most pronounced.

8.1 Limitations and Future Research

It is important to highlight that this study has several limitations. Firstly, the low response rate in SHARE was a concern in this study, as it can lead to sample selection bias and threaten the validity of research findings (Börsch-Supan et al. 2013). Selective non-response is a particular issue, as it could result in a biased sample if non-responders differ in important ways from responders. For example, if individuals with more health problems are less likely to respond, the study's results may underestimate the prevalence of frailty. However, the research team of SHARE conducted an investigation into the possibility of selective non-response in wave 4 and concluded that there was a minimal indication of bias concerning factors such as age, health status, gender, household composition, and occupation (Börsch-Supan & Krieger, 2014). This provides some reassurance that the sample is not systematically biased. To account for non-response and sample attrition, the study used calibrated weights in all analyses, which are designed to adjust for potential bias and improve the accuracy of estimates (Börsch-Supan & Jürges, 2005).

Another limitation of this study is its reliance on self-reporting, particularly for all dimensions of frailty except for maximum grip strength. This reliance on self-reporting may introduce potential biases, such as cross-cultural differences in reporting styles and gender differences in reporting accuracy (Jürges, 2007; Zajacova et al., 2017). While validation studies have generally supported the accuracy of self-reports as a measure of prevalent chronic diseases, the potential for bias cannot be entirely ruled out (Okura et al. 2004).

As noted in the discussion, it is important to acknowledge that this study solely examines non-institutionalized individuals and that the percentage of older adults residing in nursing homes is lower in Southern European countries compared to other regions. Consequently, this could potentially result in an overrepresentation of older individuals with poorer health in the Southern European countries included in the study. Nonetheless, it is worth noting that the exclusion of institutionalized individuals from analyses is a common practice in studies utilizing the SHARE dataset, given the limited availability of information regarding the health status of this population across certain countries in the dataset.

Finally, although the study provides a comprehensive analysis of frailty among different age-related population groups and its association with welfare state regime typologies, it is important to acknowledge the limitations of a cross-sectional design. One major limitation is the inability to establish causality between the variables of interest. Additionally, the cross-sectional design only provides a snapshot of individuals' health status at a specific point in time and does not allow the tracking of changes in health as individuals age. Despite these

limitations, the study offers valuable insights into the relationship between frailty and socio-economic factors among different age groups in Europe.

Based on the limitations identified in this study, several suggestions for future research can be made. Firstly, future studies could incorporate other sources of data, such as administrative records and medical examinations, to complement self-reported measures and improve the accuracy of health assessments. Additionally, longitudinal studies are needed to provide a more comprehensive understanding of the relationship between frailty and socioeconomic factors over time. Such studies could track changes in health status among individuals as they age and assess the impact of various interventions and policy initiatives on health outcomes.

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Appendix A

Table A1. Frailty Index (FI) deficit variables and cut-off points

SHARE code	**Variable description**	**Cut-Point**
bmi	Body mass index (Kg/m2) deficit	<18.5 or ≥30 = 1 25 to <30 = 0.5 18.5 to <25 = 0
br015_ br016_	Activities requiring moderate or vigorous physical activity: hardly ever, or never	Yes = 1, No = 0
maxgrip	Grip strength (kg) deficit	Men: - For BMI ≤ 24, GS ≤ 29 - For BMI > 24 and ≤ 28, GS ≤ 30 - For BMI > 28, GS ≤ 32 Women: - For BMI ≤ 23, GS ≤ 17 - For BMI > 23 and ≤ 26, GS ≤ 17.3 - For BMI > 26 and ≤ 29, GS ≤ 18 - For BMI > 29, GS ≤ 21
mh002_	Sad or depressed last month	Yes = 1, No = 0
mh003_	Hopelessness (Absence of hopes for the future)	Yes = 1, No = 0
mh011_	Diminution in the desire for food	Yes = 1, No = 0
mh013_	Fatigue	Yes = 1, No = 0
mh016	Lack of enjoyment	Yes = 1, No = 0
orienti	Impaired orientation in time test (i.e. less than good): date, month, year and day of week	Yes = 1, No = 0
ph003_	Self-report of health	Excellent = 0 Very good = 0.25 Good = 0.5 Fair = 0.75 Poor = 1
ph004_	Long-term illness	Yes = 1, No = 0
ph006d1	Doctor told you had: heart attack	Yes = 1, No = 0
ph006d10	Doctor told you had: cancer	Yes = 1, No = 0
ph006d12	Doctor told you had: Parkinson disease	Yes = 1, No = 0
ph006d14	Doctor told you had: hip fracture or femoral fracture	Yes = 1, No = 0
ph006d2	Doctor told you had: high blood pressure or hypertension	Yes = 1, No = 0
ph006d4	Doctor told you had: stroke	Yes = 1, No = 0

ph006d5	Doctor told you had: diabetes or high blood sugar	Yes = 1, No = 0
ph006d6	Doctor told you had: chronic lung disease	Yes = 1, No = 0
ph006d19 ph006d20	Doctor told you had: arthritis	Yes = 1, No = 0
ph089d1	Bothered by: falling down	Yes = 1, No = 0
ph089d2	Bothered by: fear of falling down	Yes = 1, No = 0
ph089d3	Bothered by: dizziness, faints or blackouts	Yes = 1, No = 0
ph048d1	Difficulties: walking 100 metres	Yes = 1, No = 0
ph048d3	Difficulties: getting up from chair	Yes = 1, No = 0
ph048d5	Difficulties: climbing one flight of stairs	Yes = 1, No = 0
ph048d7	Difficulties: reaching or extending arms above shoulder	Yes = 1, No = 0
ph048d9	Difficulties: lifting or carrying weights over 5 kilos	Yes = 1, No = 0
ph049d1	Difficulties: dressing, including shoes and socks	Yes = 1, No = 0
ph049d10	Difficulties: telephone calls	Yes = 1, No = 0
ph049d11	Difficulties: taking medications	Yes = 1, No = 0
ph049d12	Difficulties: doing work around the house or garden	Yes = 1, No = 0
ph049d13	Difficulties: managing money	Yes = 1, No = 0
ph049d2	Difficulties: walking across a room	Yes = 1, No = 0
ph049d3	Difficulties: bathing or showering	Yes = 1, No = 0
ph049d4	Difficulties: eating, cutting up food	Yes = 1, No = 0
ph049d5	Difficulties: getting in or out of bed	Yes = 1, No = 0
ph049d6	Difficulties: using the toilet, including getting up or down	Yes = 1, No = 0
ph049d8	Difficulties: preparing a hot meal	Yes = 1, No = 0
ph049d9	Difficulties: shopping for groceries	Yes = 1, No = 0

Appendix B

Table B1. Multilevel regression analyses using income

	Northern Europe				Western Europe				Southern Europe				Eastern Europe			
	Age 50-59	Age 60-69	Age 70-79	Age 80+	Age 50-59	Age 60-69	Age 70-79	Age 80+	Age 50-59	Age 60-69	Age 70-79	Age 80+	Age 50-59	Age 60-69	Age 70-79	Age 80+
Constant	0.104***	0.110***	0.164***	0.185***	0.138***	0.158***	0.194***	0.239***	0.129***	0.130***	0.194***	0.279***	0.134***	0.157***	0.203***	0.288***
	(0.0042)	(0.0148)	(0.0126)	(0.0065)	(0.0099)	(0.0110)	(0.0178)	(0.0203)	(0.0074)	(0.0094)	(0.0179)	(0.0154)	(0.0197)	(0.0098)	(0.0162)	(0.0119)
Gender (ref.: Men)																
Women	0.0502***	0.0217	0.00398	0.0325*	0.0214	0.00703	0.0287**	0.0681***	0.0204	0.0366***	0.0465***	0.0646***	0.00191	0.0074	0.0329***	0.0433***
	(0.0072)	(0.0254)	(0.0030)	(0.0191)	(0.0150)	(0.0065)	(0.0113)	(0.0101)	(0.0145)	(0.0093)	(0.0070)	(0.0196)	(0.0066)	(0.0113)	(0.0064)	(0.0132)
Income (ref.: 1st quartile)																
2nd quartile	0.0376**	0.0216***	-0.0127	-0.00825**	0.00473	-0.012	-0.0245	0.0039	-0.0303***	-0.000884	-0.0153***	-0.0213***	-0.0452***	-0.0236***	-0.0151**	-0.00626
	(0.0184)	(0.0057)	(0.0191)	(0.0038)	(0.0119)	(0.0138)	(0.0214)	(0.0178)	(0.0106)	(0.0078)	(0.0047)	(0.0054)	(0.0122)	(0.0076)	(0.0062)	(0.0173)
3rd quartile	0.00473	0.00852***	-0.0284**	-0.0181*	-0.0470***	-0.0320***	-0.0342**	-0.000826	-0.0397***	-0.0135**	-0.0336***	-0.0383*	-0.0671***	-0.0495***	-0.0441***	-0.0569***
	(0.0178)	(0.0011)	(0.0114)	(0.0104)	(0.0107)	(0.0093)	(0.0162)	(0.0108)	(0.0094)	(0.0055)	(0.0069)	(0.0201)	(0.0196)	(0.0039)	(0.0097)	(0.0081)
4th quartile	-0.0298***	-0.0166***	-0.0620***	-0.0389	-0.0671***	-0.0586***	-0.0577***	-0.0314*	-0.0465*	-0.0307***	-0.0482***	-0.0541	-0.0761***	-0.0579***	-0.0364	-0.0183*
	(0.0014)	(0.0051)	(0.0126)	(0.0303)	(0.0082)	(0.0117)	(0.0147)	(0.0166)	(0.0257)	(0.0054)	(0.0122)	(0.0358)	(0.0278)	(0.0087)	(0.0260)	(0.0095)
*Interaction: Gender * Income*																
Women * 2nd quartile	-0.0446	-0.00365	0.00611	-0.00914	-0.0211	0.0017	-0.000592	-0.0327***	0.00692	-0.0216***	-0.0147**	0.0177	0.00224	0.0039	-0.0154*	-0.0178
	(0.0283)	(0.0026)	(0.0121)	(0.0356)	(0.0174)	(0.0138)	(0.0158)	(0.0060)	(0.0043)	(0.0053)	(0.0057)	(0.0150)	(0.0056)	(0.0158)	(0.0086)	(0.0147)
Women * 3rd quartile	-0.0489**	-0.017	0.00234	0.00873	-0.0088	-0.0000231	-0.00712	-0.0333	-0.00613	-0.0259**	0.000935	-0.0031	0.0139	0.0131	-0.00917	0.0096
	(0.0191)	(0.0226)	(0.0050)	(0.0259)	(0.0166)	(0.0097)	(0.0128)	(0.0237)	(0.0137)	(0.0103)	(0.0041)	(0.0240)	(0.0116)	(0.0124)	(0.0151)	(0.0519)
Women * 4th quartile	-0.0386***	-0.0222	0.0287**	0.00519	-0.0104	0.00608	-0.00826	-0.0287**	-0.00921	-0.0190**	-0.00875	0.0371	0.0101	0.00417	0.0411**	0.0624
	(0.0078)	(0.0209)	(0.0112)	(0.0314)	(0.0150)	(0.0074)	(0.0154)	(0.0123)	(0.0229)	(0.0088)	(0.0101)	(0.0246)	(0.0192)	(0.0094)	(0.0198)	(0.0947)
Urban	0.00221	-0.00487	-0.00393***	0.00741	0.00902*	0.00194	-0.00685	-0.0105	-0.0129	-0.00487**	-0.00129	-0.00674	0.0204*	0.000664	-0.0037	-0.0166***
	-0.00453	-0.00391	-0.0000834	-0.0167	-0.00494	-0.00385	-0.00587	-0.00753	-0.00888	-0.00213	-0.0129	-0.00995	-0.0112	-0.00384	-0.00559	-0.00564
Living with spouse/partner	-0.00812***	-0.00816	-0.0125***	-0.0165***	0.00219	-0.00723*	-0.00738***	-0.0265***	-0.0142***	-0.00497	-0.0203***	-0.0281**	-0.00441	-0.00403	0.00316	-0.0210***
	-0.000982	-0.0148	-0.00293	-0.00208	-0.00269	-0.00374	-0.00284	-0.0088	-0.00346	-0.00356	-0.00182	-0.0112	-0.00937	-0.00574	-0.00699	-0.00404
Observations	1,238	2,485	1,972	947	4,197	6,841	4,834	2,547	2,078	4,298	3,372	2,077	2,183	4,972	3,780	1,943
Number of groups	2	2	2	2	6	6	6	6	4	4	4	4	5	5	5	5

Note: Weighted using calibrated individual cross-sectional weights
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix C

Table C1. Multilevel regression analyses of frailty index by welfare state regime and age groups (50-64, 65-74, 75-84, 85+)

	Northern Europe				Western Europe				Southern Europe				Eastern Europe			
	Age 50-64	Age 65-74	Age 75-84	Age 85+	Age 50-64	Age 65-74	Age 75-84	Age 85+	Age 50-64	Age 65-74	Age 75-84	Age 85+	Age 50-64	Age 65-74	Age 75-84	Age 85+
Constant	0.125***	0.137***	0.158***	0.202***	0.126***	0.167***	0.206***	0.253***	0.122***	0.160***	0.201***	0.328***	0.162***	0.179***	0.255***	0.298***
	(0.0174)	(0.0090)	(0.0042)	(0.0007)	(0.0037)	(0.0074)	(0.0150)	(0.0233)	(0.0094)	(0.0148)	(0.0194)	(0.0223)	(0.0080)	(0.0058)	(0.0155)	(0.0092)
Gender (ref.: Men)																
Women	0.0148**	0.0174***	0.0226*	0.0394***	0.0212**	0.0116	0.0421***	0.0637***	0.0300*	0.0329***	0.0730***	0.0658***	0.0025	0.0238***	0.0385***	0.0646***
	(0.0064)	(0.0004)	(0.0125)	(0.0045)	(0.0090)	(0.0071)	(0.0091)	(0.0157)	(0.0159)	(0.0047)	(0.0122)	(0.0207)	(0.0038)	(0.0066)	(0.0125)	(0.0185)
Level of Education (ref.: Low)																
Medium	-0.0192*	-0.00772***	0.00116	-0.00919	-0.0194***	-0.0237***	-0.0170**	0.0108	-0.0159	-0.0157***	-0.0484***	-0.00169	-0.0468***	-0.0165***	-0.0296***	-0.00749
	(0.0112)	(0.0029)	(0.0176)	(0.0097)	(0.0049)	(0.0082)	(0.0082)	(0.0166)	(0.0119)	(0.0050)	(0.0084)	(0.0299)	(0.0069)	(0.0051)	(0.0042)	(0.0193)
High	-0.0386**	-0.0303***	(0.0083)	-0.0327*	-0.0385***	-0.0438***	-0.0421***	-0.0476**	-0.0299***	-0.0174**	(0.0141)	-0.0531*	-0.0757***	-0.0548***	-0.0680***	(0.0149)
	(0.0151)	(0.0016)	(0.0076)	(0.0176)	(0.0059)	(0.0056)	(0.0101)	(0.0230)	(0.0057)	(0.0087)	(0.0130)	(0.0281)	(0.0126)	(0.0083)	(0.0089)	(0.0250)
*Interaction: Gender * Level of education*																
Women * Medium	0.00603	-0.00482	0.00362	-0.0262***	-0.0114	-0.00609	-0.0247***	-0.0384**	-0.019	-0.0204***	0.00685	-0.0591*	0.0108*	-0.0158**	-0.0211***	-0.0296
	(0.0065)	(0.0033)	(0.0254)	(0.0090)	(0.0091)	(0.0095)	(0.0078)	(0.0156)	(0.0235)	(0.0069)	(0.0091)	(0.0348)	(0.0061)	(0.0068)	(0.0042)	(0.0280)
Women * High	-0.00565	-0.0107	-0.0188	0.0468	-0.0144***	-0.00542	-0.0337***	-0.0236	-0.0240**	-0.0410***	-0.0224	-0.0659**	0.00186	-0.00406	0.0113	-0.0622**
	(0.0049)	(0.0098)	(0.0248)	(0.0769)	(0.0054)	(0.0034)	(0.0053)	(0.0350)	(0.0120)	(0.0096)	(0.0201)	(0.0288)	(0.0070)	(0.0155)	(0.0142)	(0.0282)
Urban	0.00234	-0.00348***	0.0055	-0.0062	0.00829	-0.000664	-0.0147**	-0.01	-0.00493	0.000248	-0.0000439	-0.0193***	0.0201*	-0.00133	0.00155	-0.0154
	(0.0051)	(0.0009)	(0.0096)	(0.0147)	(0.0054)	(0.0051)	(0.0072)	(0.0100)	(0.0063)	(0.0048)	(0.0174)	(0.0072)	(0.0109)	(0.0050)	(0.0047)	(0.0169)
Living with spouse/partner	-0.0224***	-0.0226***	-0.0237**	-0.00566***	-0.0141***	-0.0206***	-0.0214***	-0.0219***	-0.0192***	-0.0214***	-0.0112*	(0.0254)	-0.0178***	(0.0068)	-0.00990**	(0.0050)
	(0.0054)	(0.0028)	(0.0109)	(0.0014)	(0.0023)	(0.0015)	(0.0039)	(0.0039)	(0.0017)	(0.0037)	(0.0068)	(0.0316)	(0.0042)	(0.0062)	(0.0043)	(0.0111)
Observations	2,388	2,507	1,332	415	7,604	6,050	3,635	1,130	4,170	4,013	2,778	864	4,632	4,617	2,881	748
Number of groups	2	2	2	2	6	6	6	6	4	4	4	4	5	5	5	5

Note: Weighted using calibrated individual cross-sectional weights.
Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*