Educational and Gender Gaps in Cognitive Impairment-Free Life Expectancy across Europe

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Abstract

Dementia is a significant global concern, impacting care dependency and disability among older individuals. In Europe, around 14.1 million people live with dementia, a number projected to increase to 15.9 million by 2040. The associated costs have already surpassed 226.7 billion euros in 2022. Women and those with lower education levels are particularly vulnerable to cognitive impairment. While research has started exploring this connection, studies on how long individuals live with and without cognitive impairment by gender and education in European countries are limited. Our study addresses this gap by estimating Cognitive Impairment-Free Life Expectancy (CIFLE) and Cognitively Impaired Life Expectancy (CILE) by gender and education across 10 European countries using data from the Survey of Health Aging and Retirement in Europe. Preliminary findings reveal gender and education-based disparities, with higher education associated with a longer cognitively healthy life. Women, although having higher CIFLE estimates, spend a larger share of their remaining lives cognitively impaired. In most countries, both men and women with a lower education level experience more remaining years of cognitive impairment compared to years of cognitive health at age 50. Further analysis will refine these estimates and explore different operationalizations of cognitive impairment measures.

Background

Dementia is currently the seventh leading cause of death and a significant contributor to care dependency and disability among older individuals globally (WHO, 2021). In Europe, there are approximately 14.1 million people living with dementia (ibid.). Given the aging population in Europe and the lack of a cure for dementia, it is projected that this number will increase to 15.9 million by 2040 (Ferri et al., 2005). As the number of individuals affected by dementia continues to rise, so too will the associated social and informal healthcare costs, which have already surpassed 226.7 billion euros in 2022 (IQVIA & EFPIA, 2022). In Europe, dementia has nearly double the impact on disability-adjusted life years among women (WHO, 2021). Therefore, addressing age-related cognitive decline and supporting vulnerable groups within the aging European population is of paramount importance.

Although dementia is the most common cause of cognitive decline, mild cognitive disorders do not always progress to dementia (Hussenoeder et al., 2020; Plassman et al., 2008). Nonetheless, cognitive impairments are linked to negative health consequences, including a reduced overall

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quality of life for affected individuals (Hussenoeder et al., 2020), increased risk of physical limitations (Lee et al., 2005), and a higher likelihood of experiencing depression (Han et al., 2021). Notably, cognitive impairment not only affects the number of years a person lives with a disability, but also reduces their overall life expectancy, typically by 3 to 5 years (Winblad et al., 2016).

Cognitive impairment can lead to adverse effects that extend beyond the individual, impacting their family and social network. Cognitive impairment is often followed by the need for informal care, which affects both economic and emotional aspects of families (Baumgarten et al., 1992; Morris et al., 2021). A recent study in Europe shows that households with a member experiencing cognitive impairment face a 48% increase in the costs associated with maintaining their standard of living (Morris et al., 2021). This further highlights the need to address and support vulnerable groups in the population.

Women and individuals with low education are particularly vulnerable to the impacts of cognitive health. Women tend to experience a delayed onset of cognitive impairment compared to men, and they typically enjoy longer life expectancies with good cognition (Hale et al., 2020; Nielsen et al., 2022). Nielsen et al. (2022) demonstrated that women have an approximately 2-year advantage in life expectancy with good cognitive function. However, women also have longer life expectancies with poor cognition, resulting in a larger portion of their lives spent with cognitive impairment compared to men (ibid.). This gender disparity is primarily attributed to women's survival advantage (Hale et al., 2020; Nielsen et al., 2022). Moreover, impaired cognitive function is more strongly associated with disability in women than in men (Canon & Crimmins, 2011; Lee et al., 2005).

Previous studies have shown that education is a risk factor for cognitive impairment (Livingston et al., 2017). While low education is associated with higher lifetime risk of cognitive impairment, lower mean age at onset, and more years lived impaired (Hale et al., 2020), high education reduces risk of cognitive decline patterns that can lead to dementia (Clouston et al., 2020). These educational differences in patterns of cognitive decline can be attributed to both the protective effects of education and varying levels of exposure to risk factors. Individuals with higher educational attainment have better cognitive reserve, which refers to the brain's capacity to perform cognitive tasks effectively even when neuropathological damage is present (Winblad et al., 2016). A study conducted by Brayne et al. (2010) shows that there are minimal educational differences in the clinical pathology of cognitive decline, but education does serve to mitigate the impact of pathology on the clinical expression of dementia. Furthermore, education plays a crucial role in providing cognitive stimulation and fostering active participation in social networks throughout an individual's life, both of which are associated with a reduced risk of dementia (Cornwell & Laumann, 2015; Fratiglioni et al., 2000; Reed et al., 2011).

On the contrary, individuals with lower levels of education are more exposed to cognitive impairment risks factors. Low educated individuals are more likely to engage in deleterious health behaviours, and develop comorbidities at younger ages compared to highly educated, particularly cardiometabolic conditions, both of which are recognized as risk factors for cognitive impairment. For instance, smoking is associated with a 50-80% increase in the risk of dementia (Winblad et al., 2016).

While research has begun to explore the connection between education, gender, and cognitive impairment, studies investigating how long individuals live cognitively impaired by gender and education in countries beyond limited Western European are scarse. For example, using a pooled European sample, Gruber (2020) found that cognitive abilities decline with age but improve with increased years of education, with women notably outperforming men. However, it is important to consider substantial regional variations in cognitive health when studying Europe (Formanek et al., 2019). Another European study by Nielsen et al. (2022) estimated life expectancy with good and poor cognitive function, focusing primarily on population-level estimates. Therefore, there is a notable gap in providing a comprehensive account of gender-based educational disparities in the duration of a cognitively healthy life across European countries. Our study seeks to address this research gap by estimating the duration of Cognitive Impairment-Free Life Expectancy (CIFLE) and Cognitively Impaired Life Expectancy (CILE) by gender and education across 10 European countries. We achieve this by estimating differential mortality and cognitive health using a harmonized single data source, data from the Survey of Health Aging and Retirement in Europe (SHARE), thereby enabling an exploration of countries that have traditionally been overlooked in the existing literature.

Data and Methods

Data

This study employs data from the Survey of Health, Ageing and Retirement in Europe (SHARE). SHARE contains cross-national longitudinal information on demographic, socioeconomic and health measures, as well as, vital status for 28 European countries. Additionally, by conducting end-of-life interviews, it attempts to collect detailed and accurate information of deaths. The survey started in 2004 and has been conducted biennially. It covers private households and their members aged 50 or older. We limited countries according to their mortality data quality, which was established elsewhere (Stonkute et al., 2023).

Data from all available waves are analysed, except wave 3. The third wave of data collection for SHARE is called SHARELIFE, which focuses on people's life histories instead of a regular questionnaire, thus observations from this wave are missing.

Measurement of Cognitive Function

We employ the approach developed and validated by Crimmins et al. (2011) to define cognitive impairment. This approach relies on four cognitive functioning scores, which are used to identify adults with cognitive impairment with dementia and cognitive impairment without dementia using data from the Health and Retirement Study in the United States. To gather these cognitive functioning scores, we utilized a set of questions available in SHARE, which was previously explained in detail in a separate study (Morris et al., 2021). These questions assess performance in immediate and delayed recall, as well as verbal and numeric fluency. We create the overall index by summing the scores obtained from all four questions, with a maximum achievable score of 26. Individuals with scores ranging from 0 to 11 are classified as cognitively impaired, while those scoring between 12 and 26 are categorized as cognitively healthy.

Other variables

We group levels of education following the International Standard Classification of Education (Statistics UIS, 2012): low education (lower secondary education or less, ISCED 0-2); medium education (upper secondary or vocational training, ISCED 3-4); and high education (tertiary education or higher, ISCED 5-6). Gender available in the data is binary, corresponding to men and women.

Analytical approach

In this study, we create life tables specific to gender and education using a multivariate life table approach, explained in details elsewhere (Stonkute et al., 2023). To begin, we employ a series of discrete-time regression models, which are applied separately for each country and gender. The models include age, age-squared, and educational level. In order to estimate these models, it is essential to have survival data for individuals spanning at least two consecutive time points, leading to a restriction in our data to individuals participating in at least two consecutive waves. We use the estimated probabilities of death by age, gender and education to build life tables.

We model the mortality of a synthetic cohort by simulating the death of each individual within this cohort. Initially, we start with a population of 500,000 men and women distributed across age intervals ranging from [50–52) to [110). To determine whether an individual in an age interval x survives to the next interval (x + n), we assess the probability of death for each person. If this probability is lower than a randomly drawn value from a uniform distribution, the individual continues to the next age interval. This iterative process is carried out for every person in the cohort until they are eventually eliminated by death. This allows us to generate synthetic lifetimes for the entire cohort. From these synthetic lifetimes, we can calculate various statistics, such as life expectancy, by averaging over the simulated lifetimes.

Subsequently, we employ the Sullivan method (Sullivan, 1971) to estimate CIFLE and CILE. The prevalence estimates for cognitive impairment are calculated using a baseline sample, and we excluded proxy responses, as well as, missing data related to any of the four components used to measure cognitive impairment.

Preliminary results

Figure 1 displays preliminary estimates of CIFLE by gender and education for the studied countries. The data reveals that, on average, women tend to experience more years of life without cognitive impairments compared to men. However, it's important to note that the extent of this gender gap varies substantially based on the level of education and the specific country under consideration. The largest gender gaps can be seen among the higher educated, where in countries, such as France and Slovenia highly educated women can live around 9 years longer without cognitive impairment. Meanwhile, Danish women are only 1.2 years ahead of men. Among individuals with low education, not only the gender gaps are smaller but also estimates from Spain and Slovenia suggest that women enjoy shorter lives cognitively healthy than men.

Higher educational levels are also linked with a lengthier cognitively healthy life. The educational gap, defined as the difference in CIFLE between high and low education, is most minimal in Sweden - 8.9 years for men and 9.3 years for women. Meanwhile, Slovenia indicates the largest differences - 16.1 and 22.5 for men and women, respectively. For instance, Slovenian women

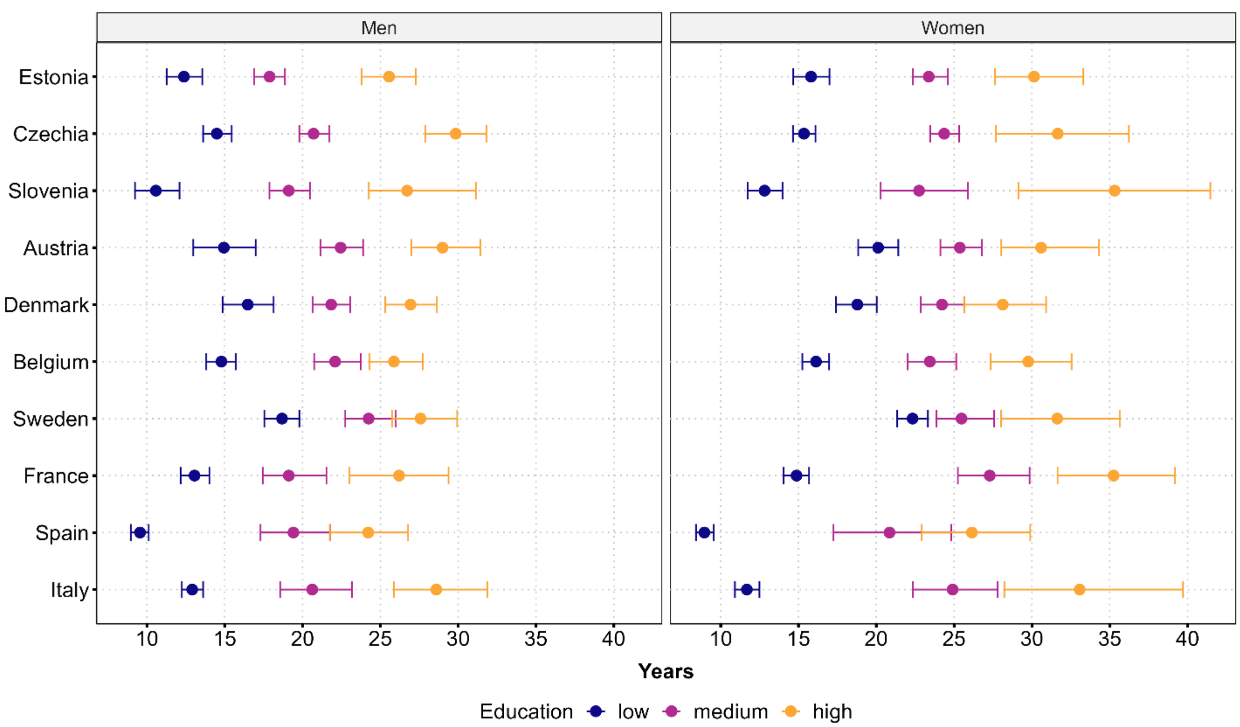

Figure 1. Remaining Cognitive Impairment-Free Life Expectancy at age 50 by gender and education

with low education can anticipate an average of 12.8 more years of cognitively healthy life after reaching the age of 50. In contrast, their counterparts with a higher level of education can look forward to a cognitive impairment-free lifespan that is three times longer, at 35.3 years.

It is also important to note heterogeneity in educational gradient. Firstly, the difference between the highest and the lowest educational levels varied greatly by gender. With the exception of Austria and Denmark, women display more pronounced educational disparities. For instance, in France, there is a substantial 20.4-year gap between women with high and low education levels, whereas among men, this gap is 7 years smaller. In Czechia and Estonia, the difference is only about 1 year smaller, and in Sweden, it is just 0.4 years. Secondly, the disadvantage experienced by those with lower education levels is particularly evident, as the estimates for many countries show a greater distance from the medium education levels compared to the difference between medium and high education levels. Particularly for Southern European women, the gap between low and medium education is between 4.5 and 6.6 years larger compared to the gap between medium and high education.

Reflecting these results in relative terms is crucial, particularly concerning the share of an individual's overall life expectancy during which they can anticipate living without cognitive

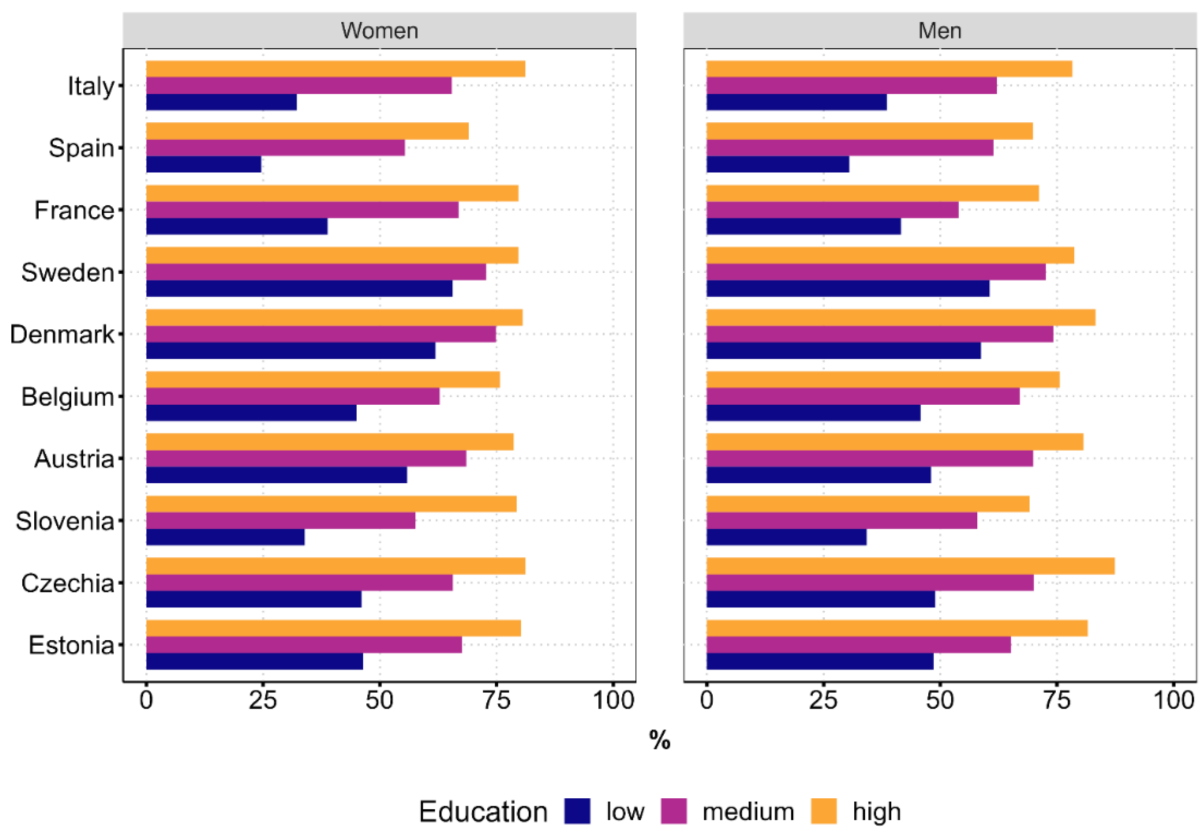

Figure 2. Proportion of remaining life expectancy at age 50 expected to live without cognitive impairment

impairment. This information is visually represented in Figure 2. Higher education was associated with a greater proportion of disability-free life, but the extent of this advantage varies considerably by country. For instance, in the case of low-educated Italian women, only 32.2% of their remaining life is expected to be spent in good cognitive health, while their highly-educated counterparts can expect more than 80%. Certain country differences are substantial to the extent that low-educated Swedish women could expect a similar proportion of their remaining life at 50 cognitively healthy, as high educated Spanish women (66% and 69%, respectively).

It is worth noticing that among the least educated irrespective of gender and country, with the exception of Denmark and Sweden, the years of life left at age 50 cognitively impaired are larger than the number of years cognitively healthy. The opposite is observed across individuals with at least high secondary education.

Next steps

Our future analytical strategy will follow three main steps. First, we intend to enhance CIFLE by utilizing more detailed categories for cognitive impairment, specifically distinguishing between cognitive impairment with and without dementia. The severity of cognitive impairment can provide valuable insights into the diverse patterns of disablement processes that underlie these expectations. Additionally, we plan to perform two sets of sensitivity analyses to assess the robustness of our findings.

First, due to a significant number of participants with missing data on cognitive tests, we will investigate whether there are distinctive age, gender, or educational patterns among these participants. We will then explore the possibility of extracting cognitive test values from various waves for individuals with missing information at baseline. Second, we aim to estimate CIFLE and CILE using different operationalizations of the cognitive impairment measure.

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