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Original Research

Longitudinal norms of frailty measured by the frailty index: A cross-national comparison using data from the survey of health, aging, and retirement in Europe (SHARE)

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ABSTRACT

Background: Frailty, a geriatric syndrome commonly used to identify vulnerable older adults, is a public health priority. However, the lack of cross-national comparisons of frailty trajectories and their distribution constrains current understanding of normative changes in frailty for residents across different countries.
Objective: To derive longitudinal percentiles of frailty using a consistent cross-country approach.
Design: Observational study using longitudinal data from the Survey of Health, Ageing and Retirement in Europe (SHARE) between 2004 and 2020.
Setting: We fit the distribution of the FI by Generalized Additive Models for Location, Scale, and Shape (GAMLSS), assessed the role of sex (male/female), education (in years), and migration status (migrant/non-migrant), and estimated the longitudinal percentiles of frailty using a consistent cross-country approach for 16 countries.
Participants: Individuals aged ≥65 years ($N = 42{,}951$) at study entry.
Measurements: Frailty index (FI) based on the accumulation of deficits in 40 items.
Results: The results show that education is protective against frailty in all countries (a decrease of 1.1 pp. in Switzerland to 5.7 pp. in Slovenia, all $p < 0.001$). In most countries, women are frailer than men and migrant individuals have higher levels of frailty than non-migrants. FI trajectories showed heterogeneity across countries. The quantiles for women and migrants suggest frailer trajectories than men and non-migrants respectively.
Conclusions: Findings from this cross-national comparison provide a framework within which the longitudinal norms of frailty trajectories from different countries can be interpreted.

1. Introduction

Frailty reflects a multi-system physiological state of increased vulnerability to impaired recovery of homeostasis after a stressor and diminished physiological reserve [1–3]. Although frailty is associated with aging, it is not inexorable [1,3]. Frailty has been operationalized in multiple ways, including the frailty phenotype and the Frailty Index (FI) [2,4,5]. The FI is a multidimensional continuous measure computed by dividing the number of deficits present in an individual by the total number of deficits. It is robust to variations in the considered items (e.g., the activities of daily living, or the specific variables to reflect mobility of the person), and reliably differentiate community-dwelling older adults at different risks of adverse outcomes [3,6,7].

The social determinants of health, defined as the conditions in which people are born, grow, live, work and age, and people's access to power, money and resources, are strongly associated with health inequities [8]. Indeed, previous literature has extensively studied the social determinants of frailty [9–11]. The progression of frailty is consistently associated with various sociodemographic factors, including age and sex. Yet, previous findings showed conflicting results about the

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association of age and sex with frailty trajectories [9,12,13]. While some studies found no significant sex differences in frailty [12,13], others reported that women had faster frailty progression than men, particularly for individuals with lower levels of frailty [9,14]. New evidence has recently reported the differential role of age and sex in the quantiles of the FI trajectory, representing the heterogeneity of FI trajectory for individuals with different levels of frailty and remarking on the heterogeneity of frailty trajectory within the same population for different levels of frailty [14].

Other social determinants of health have also been studied in relation to frailty, and the results are still mixed [11]. For instance, low socioeconomic status was reported to be associated with a greater risk of a steeper frailty progression [9–11]. In turn, some studies have found evidence to suggest that education is a protective factor for frailty [12,15]. There is also recent literature that has analyzed the health status of the older migrant population and how the conditions that exist in the destination countries change this status [16].

In addition to sociodemographic factors, immigration is a social determinant of health that has garnered attention [17–19]. Immigrating to a new country, a new environment, and culture, brings in a different lifestyle and new stressors. These changes may be associated with different levels and trajectories of frailty, and there is evident literature to support this statement. Specifically, there is evidence of regional heterogeneity in the frailty trajectories regarding the association with migrant status [16]. In particular, migrant status was reported to be associated with frailty considering Europe's northern, western, southern, and eastern regions. Additionally, the health of migrant individuals is a challenge considering the huge variability in individuals' experiences regarding the country of origin and the destiny of immigrants [20–22]. The different experiences of migrant individuals and how they relate to frailty trajectory as a general marker of health, are not well understood [21,23].

Despite the extensive literature analyzing frailty trajectories, there is still a limited number of studies analyzing frailty in a coordinated manner and with consistent analytical models and variables that allow cross-country comparison to disentangle how institutional and cultural characteristics relate to social determinants of health [12]. Most previous work has focused on analyzing the level and trajectory of the mean FI, which hinders a broader understanding of frailty. Others, instead, identified subpopulations of individuals with similar frailty progression, but this approach does not necessarily inform about most frail individuals [24]. In a previous study we used a Generalized Estimated Equations (GEE) approach to estimate the quantile trajectories of frailty [14]. However, this method does not allow for modelling subject-specific trajectories and only focuses on the marginal quantile trajectories [25].

As a result, most previous approaches ignore the analysis of individuals far from the mean trajectory, some of whom will be the most frail, and therefore, the ones in greater need of support and attention considering the subject-specific heterogeneity.

In this study, we estimate the role of social determinants of health (age, sex, education, and migrant status) and the longitudinal percentiles of frailty trajectories in different countries from Europe and Israel. By doing so we extend previous studies that focus only on the average curve of frailty. We compare the roles of both risk and protective factors across 16 countries participating in the Survey of Health Ageing and Retirement (SHARE). Finally, we compare the frailty trajectories of women and men and migrants and non-migrants for different FI percentiles and perform a cross-country comparison. Our work extends on previous research on frailty by clarifying patterns in risk and protective factors for longitudinal norms of frailty trajectories across 16 countries. Our hypothesis is that the longitudinal percentiles of frailty trajectories vary by country and social determinants of health.

2. Methods

2.1. Data

Data are from the Survey of Health, Ageing, and Retirement in Europe (SHARE), a multi-country panel database on health, socioeconomic status, and social and family networks [26,27]. We use information from people aged 65 or older at study entry from 15 European countries (Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Greece, Italy, Netherlands, Poland, Slovenia, Spain, Sweden, and Switzerland) and Israel. This work uses the regular questionnaires of waves 1–8, collected approximately every two years between 2004 and 2020. The analytical sample included all the individuals with available data on frailty and risk and protective factors at baseline (>80 %). The number of individuals per country varied from 1306 in Denmark to 3833 in Switzerland, resulting in a total sample of 42,951 individuals from the 16 countries (Table 1).

2.2. Measures

We operationalize frailty using the frailty index (FI), that is, as an accumulation of deficits and calculate the FI based on standard procedures for the SHARE study [3,9,28,29]. The 40 items included in the index consider multiple dimensions of physiological systems: self-reported health, diagnosed morbidities, mobility, difficulties to perform basic and instrumental activities of daily living, sensory impairment, body mass index deficit, and grip strength (see Supplementary Table S1 for details). The FI (range=0–1) was computed by dividing the number of deficit items for all respondents who provided valid information in at least 35 out of 40 items by the total sum score (>99 % of the respondents in each wave).

Education is measured using the reported number of years in full-time (E). We also include sex (G: 1= Female, 0= Male) and migration status (M: 1= Migrant, 0= Non-Migrant), which identify individuals born in a country other than the country they were interviewed.

2.3. Statistical approach

We apply Generalized Additive Models for Location Scale and Shape (GAMLSS) [30] to fit the distribution of frailty. The mathematical formulation of the model for the i th individual is as follows:

$$FI_i \sim f(\mu_i, \sigma_i)$$

$$g_\mu(\mu_i) = \beta_{\mu 0} + h\left(A_i, \beta_{\mu A}\right) + E_i \times \beta_{\mu E} + G_i \times \beta_{\mu G} + M_i \times \beta_{\mu M} + \gamma_i$$

$$g_\sigma(\sigma_i) = \beta_{\sigma 0} + A_i \times \beta_{\sigma A}$$

We employ the Beta distribution ($f(\mu_i, \sigma_i)$) to model the outcome variable (FI_i) since it appropriately describes variables bounded between 0 and 1. We adjust the mean (μ_i) and the scale parameter (σ_i) using covariates. This allows us to evaluate the entire distribution of the FI trajectory, specially the norms of the FI trajectory. In this context, the link function for the mean (g_μ) and the scale parameter (g_σ) is the logit function [30].

The mean trajectory of the FI is adjusted by age (A_i) using a non-parametric approach with B-splines (h(.)). We also include fixed effects for sex (G_i), education (E_i), and migrant status (M_i). We include a random intercept to account for within-person heterogeneity (γ_i) for the mean trajectory. The scale parameter of the FI distribution is linearly adjusted by age (A_i).

This approach evaluates the entire distribution of the outcome, allowing us to estimate the longitudinal quantiles of the FI trajectory for different values of risk and protective factors, accounting for individual heterogeneity. In our work, we estimate the 10th, 50th (Median), and 90th longitudinal percentiles of the FI, for the average value of education. We focus our analysis on sex and migration status and estimate the

Table 1
Descriptive statistics of the analytical sample at study entry.

Country	Region	N	Age Mean (S.D.)	Females N (%)	Education Mean (S.D.)	Migrant[(a)] N (%)	FI Mean (S.D.)
Austria	Western	2437	73.2 (6.3)	1356 (55.6)	9.1 (4.4)	221 (9.1)	0.14 (0.13)
Belgium	Western	3379	73.0 (6.4)	1722 (51.0)	7.1 (4.2)	34 (1.0)	0.18 (0.16)
France	Western	2113	73.0 (6.6)	1066 (50.4)	10.5 (3.6)	111 (5.3)	0.13 (0.11)
Germany	Western	3070	73.1 (6.4)	1542 (50.2)	11.8 (3.5)	501 (16.3)	0.16 (0.13)
Netherlands	Western	2920	73.2 (6.6)	1484 (50.8)	10.4 (4.0)	240 (8.2)	0.12 (0.10)
Switzerland	Western	3833	75.0 (7.3)	2012 (52.5)	7.2 (5.0)	105 (2.7)	0.20 (0.17)
Greece	Southern	2562	73.8 (6.8)	1398 (54.6)	7.2 (4.1)	59 (2.3)	0.17 (0.14)
Italy	Southern	1971	73.6 (6.7)	1033 (52.4)	11.9 (3.8)	56 (2.8)	0.13 (0.12)
Spain	Southern	2855	74.7 (7.0)	1625 (56.9)	10.0 (3.7)	311 (10.9)	0.16 (0.13)
Slovenia	Southern	1697	73.6 (6.5)	847 (49.9)	8.3 (5.0)	281 (16.6)	0.10 (0.09)
Denmark	Northern	1306	72.8 (6.4)	678 (51.9)	11.5 (5.0)	917 (70.2)	0.20 (0.18)
Estonia	Northern	3772	73.5 (6.5)	2146 (56.9)	11.6 (3.2)	208 (5.5)	0.18 (0.14)
Sweden	Northern	3257	74.2 (7.0)	1788 (54.9)	11.1 (3.9)	288 (8.8)	0.17 (0.14)
Czech Republic	Eastern	1582	73.5 (6.6)	849 (53.7)	8.4 (3.3)	52 (3.3)	0.25 (0.17)
Poland	Eastern	2517	74.4 (6.6)	1373 (54.5)	9.9 (3.6)	251 (10.0)	0.18 (0.13)
Israel	Asia	3680	74.5 (6.2)	2236 (60.8)	10.6 (3.8)	1081 (29.4)	0.23 (0.15)

Notes: Countries were classified into different regions following Walkden et al. (2018) [15]. S.D.: Standard Deviation. [(a)] Migrant =1 for individuals born in a country other than the country where they were interviewed.

quantiles of the trajectories considering four groups: migrant women, non-migrant women, migrant men, and non-migrant men. We set the value of years of education equal to the sample average in each country to predict the longitudinal norms of the four groups, using educational attainment as a control variable.

We replicated the estimation of the model in each country, this allows us to perform a cross-national comparison of the role of sex, education, and migrant status on the average and the predicted longitudinal norms of the FI. Additionally, it enables comparing the longitudinal quantiles of the FI trajectory for the different groups across countries. All analyses were implemented using the GAMLSS R package [30].

3. Results

3.1. Descriptive statistics

Table 1 shows the descriptive characteristics of the individuals from the analytical sample at study entry ($N = 42{,}951$). The average FI ranged from 0.10 in Slovenia to 0.25 in the Czech Republic. In most countries, the majority of participants were women, with the percentage ranging from 49.9 % in Slovenia to 60.8 % in Israel, with an average age between 72.8 (S.D.=6.4) years in Denmark and 75.0 (S.D.=7.3) years in Switzerland. Average years of education at study entry ranged between 7.1 (S.D.=4.2) in Belgium and 11.9 (S.D.=3.8) in Italy.

There were differences between migrant and non-migrant individuals within and across countries. Table 2 shows the educational attainment of migrants and non-migrants in each country, comparing the average years of education of these two groups. In most countries, the average years of education of migrants is significantly different between migrants and non-migrants. For some of these countries (Belgium, France, Estonia, and the Czech Republic), the average years of education of migrants is lower than that of non-migrants. However, for other countries (Austria, Netherlands, Switzerland, Greece, Italy, Spain, Slovenia, Denmark, and Sweden) the mean years of education among migrants is higher than that of non-migrants. Finally, in Germany and Poland, the differences between migrants and non-migrants in terms of education are not statistically significant.

3.2. The role of sex, education, and migrant status on average FI across countries

Fig. 1 shows the results of the estimation of the model for the average FI in each country (see the detailed estimation output in Table S2 in supplementary material). The results showed inconsistent results across countries; however, in most countries, female sex was associated with a higher average of FI (all $p < 0.027$). Yet, in Denmark being female was associated with a lower average of FI ($p = 0.001$), and in Slovenia, this association was not statistically significant ($p = 0.970$). In the other countries the association was positive, and the odds ratio ranged from 1.025 to 1.305 (all $p < 0.034$). For instance, an odds ratio of 1.305 ($p < 0.001$) in Greece implies that female sex is associated with an increase in the FI of 30.5 percentage points compared to male sex. For instance, assuming all other characteristics are equal, a 0.1 FI value for males would increase to 0.1305 for females on average, whereas a 0.4 FI value for males would increase to 0.522 for females on average.

The results also showed that education is a protective factor against frailty. In fact, higher educational attainment was associated with a lower FI on average in all countries (all $p < 0.001$). However, the estimates of the odd ratio range from 0.989 in Switzerland to 0.943 in Slovenia. These results indicate that, for example, in Switzerland an additional year of education reduces the mean of the FI by 1.1 percentage points on average whilst in Slovenia, an additional year of

Table 2
Average years of education of migrant and non-migrant individuals in each country.

Country	Educ mig Mean (S.D.)	Educ non-mig Mean (S.D.)	*P* (two-sided)
Austria	10.40 (5.42)	8.99 (4.38)	<0.01
Belgium	10.43 (4.82)	11.35 (3.63)	<0.01
France	9.08 (5.31)	10.40 (3.57)	<0.01
Germany	11.92 (4.03)	12.10 (3.41)	0.14
Netherlands	11.06 (4.40)	10.38 (3.46)	0.03
Switzerland	9.09 (5.57)	8.56 (4.91)	0.01
Greece	9.00 (4.80)	7.10 (3.97)	<0.01
Italy	9.74 (4.99)	6.86 (4.07)	<0.01
Spain	10.38 (6.23)	6.65 (4.79)	<0.01
Slovenia	10.88 (3.81)	9.84 (3.52)	<0.01
Denmark	13.32 (3.10)	12.08 (3.78)	<0.01
Estonia	10.37 (3.78)	10.99 (3.83)	<0.01
Sweden	11.93 (4.67)	10.45 (3.91)	<0.01
Czech Republic	10.88 (3.57)	11.88 (3.17)	<0.01
Poland	7.89 (3.61)	8.10 (3.21)	0.56
Israel	11.57 (4.60)	10.94 (5.86)	<0.01

Notes: Educ mig: years of education for migrant individuals; Educ non-mig: years of education for non-migrant individuals; *P*: is the p-value of the two-sided *t*-test to assess if the mean is significantly different between two groups using unequal variances for the groups.

education reduces the mean of the FI by 5.7 percentage points on average.

Finally, the results regarding migrant status were not consistent across countries. In most countries (Belgium, France, the Netherlands, Switzerland, Greece, Denmark, Estonia, Sweden, the Czech Republic, Poland, and Israel) migrant status was associated with higher levels of average FI. In Belgium, France, the Netherlands, Switzerland, Greece, Denmark, Estonia, Sweden, Czech Republic, Poland, and Israel being born abroad was associated with an average increase of frailty trajectories (all $p < 0.05$). For instance, in Israel being born in a country other than Israel, was associated with an increase of the average FI of 46.0 percentage points (OR=1.460). On the other hand, in Germany, Italy, and Spain the migrant status was not associated with the average FI whereas in Austria and Slovenia, migrant status was protective against worsened FI.

3.3. Norms of FI trajectory across countries by sex and migrant status

Fig. 2 depicts the predicted 10th, 50th, and 90th percentiles of the FI trajectories obtained for mean education for women (left panel) and men (right panel). The solid line shows the longitudinal norms of the FI for non-migrant individuals, while the dotted line shows the longitudinal norms of the FI for migrant individuals. The results showed that consistently across countries, the estimated quantiles of the FI trajectory for women are higher than for men, suggesting that women are consistently frailer than men.

In addition, the results suggest that migrant status differentiates the longitudinal progression of the FI percentiles in some countries (the Czech Republic, Denmark, Estonia, Greece, Israel, the Netherlands, Poland, and Sweden).

4. Discussion

We evaluated frailty trajectories in 16 countries using data from SHARE in the period 2004–2020. The heterogeneity in longitudinal frailty was assessed by looking beyond the mean curve of the FI and estimating percentile curves of the distribution of the FI trajectories, considering within-subject correlation.

In particular, we fit the entire distribution using the GAMLSS approach, compared the role of risk and protective sociodemographic and migration factors, and estimated the longitudinal trajectory of different percentiles. Specifically, we estimate the median (50th percentile) trajectory, the 90th percentile which reflects the evolution of the frailest individuals, and the 10th percentile reflecting the trajectory of the least frail individuals. The analysis was replicated in each of the 16 participating countries and allowed us to understand the consistency or differences in the role of sociodemographic and migration factors on the average FI and compare the whole distribution of the FI by estimating different percentiles across countries considering the differences according to those social determinants of health.

The work presented here, which reports percentiles of frailty trajectories based on core sociodemographic characteristics, has the potential to aid public health professionals and clinicians in identifying individuals at higher risk of frailty progression beyond the expected changes associated with their demographic and socio-economic profiles with cross-national perspective, to ultimately preserve health and promote healthy aging. The results of our study are useful for clinicians to track and understand unexpected changes in frailty that do not align with an individual's sociodemographic characteristics. This information can help alert clinicians to take steps to prevent further frailty progression.

This work contributes to the existing literature by providing evidence on the changes in frailty for migrant population, a large segment of the European population. According to the 2024 World Migration Report by the United Nations, the percentage of migrants in Europe increased from approximately 8.6 % in 2005 to 11.6 % in 2020. Furthermore, this study provides evidence beyond mean changes in frailty by analyzing the trajectories of different percentiles.

The results showed differences in the role of risk and protective factors in the average FI across countries and in the percentiles longitudinal trajectories of the FI. First, female sex is associated with a higher average FI for most countries. However, in Slovenia, this association was not statistically significant, and in Denmark was negative, showing the inconsistencies of the results regarding sex across countries. This result, found in most countries, is in keeping with previous literature [12]. While our findings generally bolster prior research that has found higher average FI among women, our cross-national comparison allows us to disentangle the variability of the results in different countries and identify countries that diverge from this pattern. Furthermore, the GAMLSS approach models the entire FI distribution. Therefore, differences detected in the average FI according to sociodemographic characteristics and migration status are reflected in the different longitudinal trajectories of the FI quantiles.

Second, higher education was associated with a lower level of FI on average in all countries. Our results strengthen prior reports showing that education is a protective factor against frailty. Furthermore, higher education might be linked to health-promoting behaviors, improved access to healthcare, and advantageous socioeconomic factors, all of which may contribute to a lower median level of frailty in a population [31,32]. The cross-national approach used in this work contributes to new evidence in the consistency of this result across different countries with different cultural, social, economic, and institutional conditions. Moreover, the association of education with frailty could suggest that socioeconomic advantages are associated with lower average frailty in

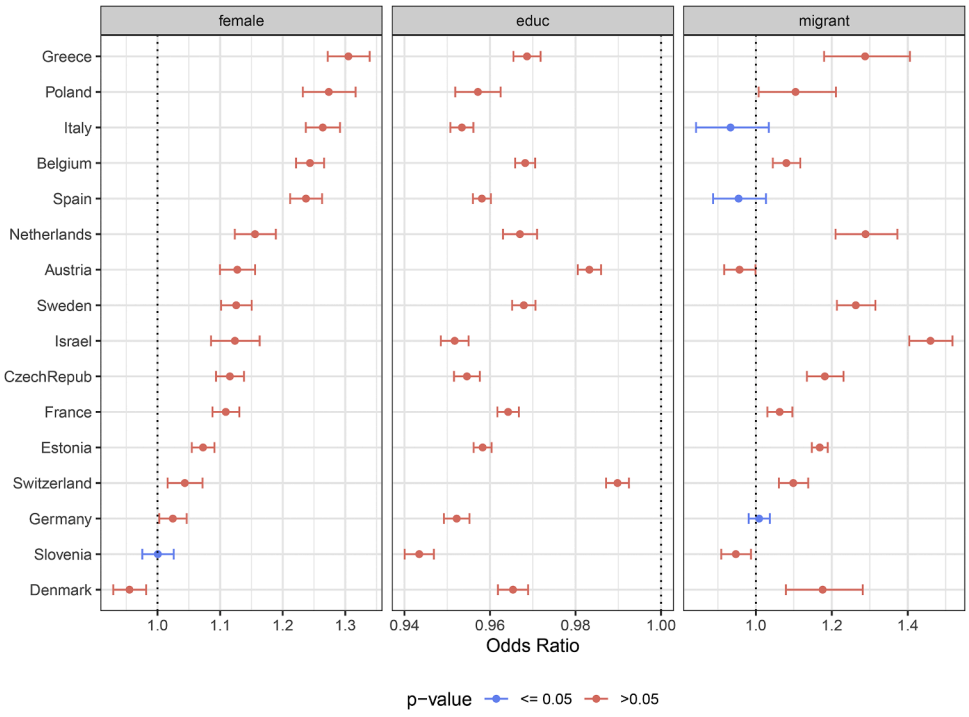


Fig. 1. Association of female sex (Left panel), education (Middle panel), and migrant status (Right panel) with the average of the FI.
Notes: Countries are ordered by the value of the estimated coefficient for the association between the female and the average of the FI. Confidence intervals are at 95 %. The vertical dotted line indicates the zero value.

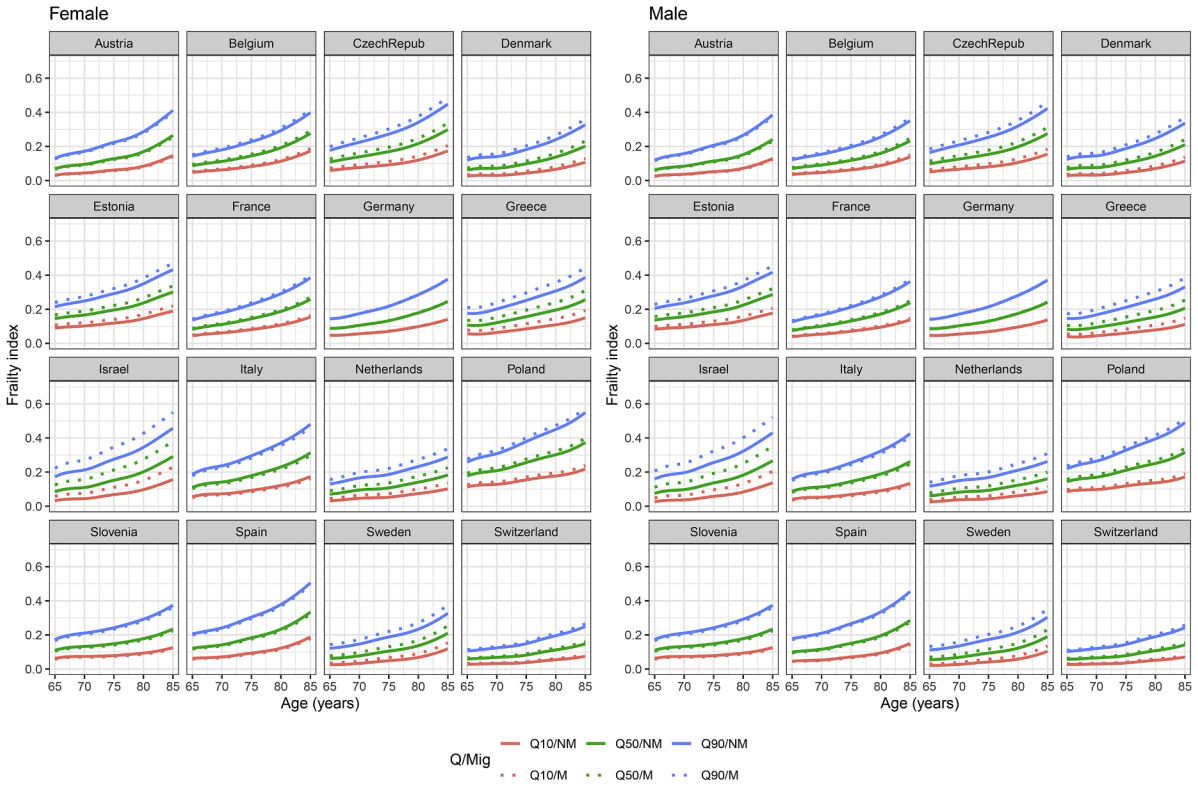


Fig. 2. Adjusted FI trajectories for 10th, 50th (Median), and 90th Percentiles.
Notes: NM: non-migrant; M: Migrant. Solid line for non-migrant individuals. Dotted line for migrant individuals. Education is set at the average level for each group.

different institutional contexts [9,11,12].

Finally, results regarding migrant status were inconsistent across countries. In most countries, the results show a positive association between migrant status and frailty, revealing an association of migration with poorer health conditions. However, in some countries, migration was negatively associated with the levels of FI or it was not a statistically

significant association. This result could be related to differences in the institutional context of the countries [16]. For instance, the heterogeneity in immigration policies across the 16 countries may explain why migrant status was not uniformly associated with frailty. Moreover, prior research has found that immigration policies are a social determinant of health, such that punitive immigrant policies reduce access to and utilization of basic healthcare services and increase fear, confusion, stigma, and severe psychological distress among foreign-born adults [33,34]. While prior research has documented the role of immigration-related policies for health outcomes among migrants within specific countries, future research should expand on this study to examine how immigration policies can serve as a risk or protective factor in longitudinal frailty trajectories among migrant populations. Additionally, the unique characteristics of the migrant population could explain our findings. For instance, more educated migrant individuals moving to countries with better institutional conditions could be the reason for a negative association between migration status and frailty. Moreover, we showed that the levels of education of the migrant population arriving in these countries are different from the natives and the patterns of the level of education also differ across countries. Thus, migrants' unique experiences, such as the characteristics of their country of origin and the motivation (e.g., asylum seekers) behind their migration can starkly shape migrants' health trajectories [35]. Our findings extend prior frailty research by providing evidence that migration experiences uniquely shape frailty trajectories. Future research could further our investigation by considering the characteristics of the country of origin and the time spent since immigration.

This study is a first step toward disentangling the association of migration status and education with the longitudinal quantiles of frailty trajectories. Future research could take an interesting approach by analyzing the interaction between educational attainment and migration status to better understand this complex relationship. At the same time, a study that focuses more closely on the social determinants of health would allow for a fairer comparison of the educational attainment of migrant and non-migrant groups across countries. Other data sources may allow for a more in depth evaluation of differences among migrant groups of individuals.

Our findings should be considered in light of some limitations. The models were estimated under the missing at random (MAR) assumption. This assumption, necessary to estimate the GAMLSS, may not be realistic while the survivor effect may be operating. In our study, 22.9 % of individuals in the analytical sample died during the follow-up period, and 46.7 % dropped out before the final observation time. Since frailty is highly associated with mortality, the MAR assumption may underestimate frailty progression because survivors are likely healthier. Future research could consider other methods to make this assumption more flexible to adjust for the entire distribution of the outcome variable while accounting for intra-individual correlation. Although we examined the distribution of percentile curves for key social determinants of health (age, sex, and migration status) we did not consider individual-level factors that have previously been shown to be associated with frailty, such as lifestyle or macro-level factors, such as income distribution, that might have provided interesting insights into country differences in frailty. Instead, we focused on several key sociodemographic and migrant factors reported to be associated with frailty. In addition, we examine how each of these sociodemographic and migrant function as risk or protective factors for frailty mean and quantile trajectories across the 16 countries, which provides new insights into country-specific potential points of intervention to preserve healthy aging. Finally, our analysis is based on an observational cohort study using structured survey data, not data from a clinical context.

Our work also has several strengths. For example, our coordinated analytical approach allows for a fair comparison of results across countries. In addition, to the best of our knowledge, this is the first study characterizing the entire distribution of frailty trajectories across different countries, looking beyond the mean curve and estimating the curves of other percentile curves. Furthermore, it illustrates the use of a methodology that could be extended to estimate normative curves for specific subpopulations of interest, beyond the ones studied here. Also, a main advantage of the methodology we used is that it allows the modelling of subject-specific trajectories.

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Declaration of the use of generative AI and AI-assisted technologies in scientific writing and in figures, images and artwork

Generative AI and AI-assisted technologies have not been utilized in the writing either to create or alter images.

Ethical statement

This research uses data from the Survey of Health, Ageing, and Retirement in Europe (SHARE). Ethical approval was granted by the Ethics Committee of the University of Mannheim for Waves 1–4. Wave 4 and the continuation of the project were further approved by the Ethics Council of the Max Plank Society. For each participating country, a separate approval was obtained by the respective ethics committees whenever it was required (for more details on the ethical approvals see: https://share-eric.eu/fileadmin/user_upload/Ethics_Documentation/SHARE_ethics_approvals.pdf).

Data availability

Access to the data collected and generated in the SHARE projects is provided free of charge for scientific use globally, subject to European Union and national data protection laws as well as the publicly available Conditions of Use (see https://share-eric.eu/data/data-access).

CRediT authorship contribution statement

Alejandra Marroig: Writing – original draft, Formal analysis, Data curation, Conceptualization. **Fernando Massa:** Writing – original draft, Formal analysis. **Ángela Gutiérrez:** Writing – original draft, Conceptualization. **Adil Supiyev:** Writing – original draft, Conceptualization. **Barış Sevi:** Writing – original draft, Conceptualization. **Graciela Muniz-Terrera:** Writing – original draft, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.tjfa.2026.100144.

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