Frailty in older-age European migrants: Cross-sectional and longitudinal analyses of the Survey of Health, Aging and Retirement in Europe (SHARE)

G.J. Walkden[a,*], E.L. Anderson[b], M.P. Vink[c], K. Tilling[a], L.D. Howe[b], Y. Ben-Shlomo[a]

[a] Population Health Science Institute, University of Bristol, Canynge Hall, 39 Whatley Road, Bristol, BS8 2PS, United Kingdom
[b] Medical Research Council Integrative Epidemiology Unit, School of Social and Community Medicine, University of Bristol, Oakfield House, Oakfield Grove, Bristol, BS8 2BN, United Kingdom
[c] Department of Political Science, Faculty of Arts and Social Sciences, Maastricht University, Grote Gracht 90-92, PO Box 616, 6200 MD, Maastricht, the Netherlands

A R T I C L E   I N F O

A B S T R A C T

Frailty correlates with morbidity and is superior to chronological age in predicting mortality. Frailty of older migrants has important implications for the demands placed on healthcare systems. Examining 95,635 Europeans in the Survey of Health, Aging and Retirement in Europe, we investigated cross-sectional and longitudinal associations between migration and frailty at ages > 50 years. We examined whether associations differed by countries' level of healthcare coverage and access for migrants and tested mediation by home-ownership and citizenship. Cross-sectionally, first-generation migrants > 50 years old were, on average, 16.4% (95% confidence interval [CI]: 14.6, 18.2%) frailer than non-migrants after confounder-adjustment. This decreased to 12.1% (95% CI: 10.1, 14.1%) after adjustment for citizenship. The strength of association between migrant status and frailty was greater in migrants from low-or-middle-income countries, compared with migrants from high-income countries. Migrants into Northern, Western and Eastern Europe were 37.3% (95% CI: 33.2, 41.5%), 12.2% (95% CI: 10.0, 14.6%) and 5.0% (95% CI: 0.5, 9.6%) frailer than non-migrants, respectively, but migrants into Southern Europe were no frailer than non-migrants. The strength of association between migrant status and frailty was greater in countries with lower healthcare coverage and access for migrants. However, citizenship attenuated this difference. Longitudinally, migrants were frailer than non-migrants at 50 years old and trajectories converged over time until migrants and non-migrants were equally frail by 80–90 years. Our work finds no evidence of the 'healthy migrant effect' outside of Southern Europe in older migrants and suggests that acculturation is a key determinant of migrant health.

1. Introduction

By 2010, Europe hosted 72.6 million migrants (8.7% of the European population) (Koser and Laczko, 2010) and the migrant proportion continues to grow (Rechel et al., 2013). Reasons for migration are heterogeneous and may be driven by ill health, educational and occupational possibilities, or by external forces such as trafficking, persecution, conflict or natural disaster (Laczko and Appave, 2013).

Although immigrants, on average, have lower socio-economic status (SES) than native-born comparators (Weitoft et al., 1999), migrant populations are frequently healthier than non-migrant populations on arrival in their host countries. This is known as the 'healthy migrant effect' (Kennedy et al., 2015; Rechel et al., 2013). Their health advantage may decrease or reverse over time because (a) acculturation causes immigrants to behave increasingly like native-born populations in socio-economic terms and health-related behaviours and/or (b)

adverse exposures during early life may be latent at the time of migration and emerge in later life (i.e. post-migration) (Solé-Auró and Crimmins, 2008; Williams, 1993). In addition, citizenship rights and access to health care for migrants may have long-term impacts on economic and health outcomes (Malmusi, 2014). Countries with policies that are more inclusive of migrants are often countries with greater wealth, nationalised healthcare systems, a strong commitment to equal rights and opportunities and countries with higher migrant proportions (Huddleston et al., 2015).

Frailty is a multifactorial state of physiological dysregulation, vulnerability to stressors and increased risk of poor health outcomes due to diminished reserve (Malaguarnera et al., 2013) which is superior to chronological age in predicting mortality in European populations (Brothers et al., 2014; Romero-Ortuno and Kenny, 2012). It is influenced by biological factors such as ageing, multi-morbidity and functional status (Gobbens et al., 2010), cognitive and psychological factors

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│ Original sample:                     │
│ 109,474 unique participants across   │
│ SHARE^a waves 1-5 [218,084 interviews]│
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Excluded:
13,839 unique participants (12.6 %)
[24,337 interviews]

3,967 participants (3.6 %) aged <50 years
[5,380 interviews]

13 participants (0.01 %) changed migrant
status over the survey timeline [39 interviews]

3,698 individuals (3.4 %) living in Israel (very
different demographic structure to the rest of
Europe and MIPEX^b unavailable for Israel)
[7,114 interviews]

6,211 individuals (5.7 %) with an incomplete
set of exposure, covariate or outcome
variables at any interview [11,804 interviews]

Final sample:
95,635 unique participants across
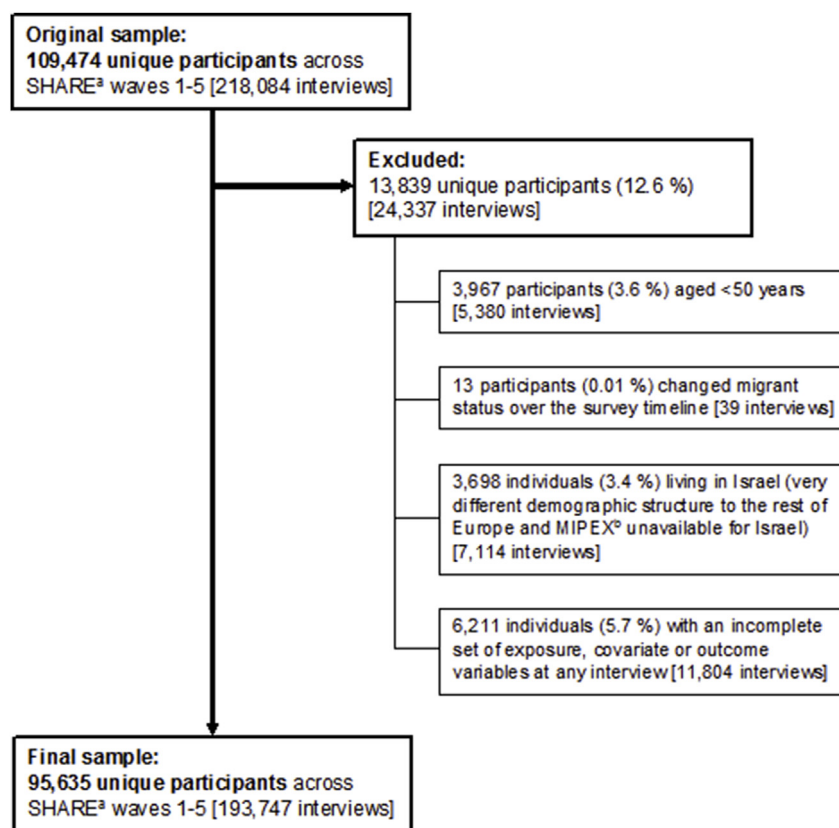SHARE^a waves 1-5 [193,747 interviews]

Fig. 1. Participants retained in the final study sample.
[a] Survey of Health, Aging and Retirement in Europe.
[b] Migrant Integration Policy Index.

(Levers et al., 2006) and socio-economic factors including education, wealth (Etman et al., 2012) and social vulnerability (Casale-Martínez et al., 2012).

Previous cross-sectional studies using the Survey of Health, Aging and Retirement in Europe (SHARE) have reported that migrants older than 50 years are significantly more likely to be depressed than non-migrants (Aichberger et al., 2010; Ladin and Reinhold, 2013) and identified significant regional heterogeneity in frailty (Brothers et al., 2014; Solé-Auró and Crimmins, 2008). Solé-Auró and Crimmins (2008) reported that dependant on country, measures of health and functional ability are either non-differential or significantly worse in European migrants compared with natives. Brothers et al. (2014) find that migrants from low or middle income countries (LMIC) exhibit significantly increased frailty compared to migrants born in high income countries (HIC) and natives in Northern and Western Europe but are no frailer than natives in Southern and Eastern Europe. Observations that migrant versus non-migrant health differences vary by host country migrant integration policies (Giannoni et al., 2016; Malmusi, 2014), by their country of origin economic status and by European host region, and are inversely related to whole-population health (Brothers et al., 2014; Solé-Auró and Crimmins, 2008), highlight the potential role that country-level factors may play in migrant versus non-migrant health inequalities. However, descriptions of the health of migrants in Europe are scant, particularly longitudinally (Rechel et al., 2013).

We hypothesised that differences in frailty, and change in frailty over time, between first generation migrants and non-migrants in Europe would be modified by migrants' economic origins, host region and, for the first time, country-level migrant integration policies (the magnitude of any migrant health inequality being reduced by more inclusive migrant health policies). We aimed to quantify the extent to which post-migration socio-economic status and, for the first time,

citizenship may explain these expected differences in frailty and hypothesised that acquisition of citizenship may attenuate effect modification by host country migrant integration policies. This work builds upon existing cross-sectional studies of European migrant health in SHARE (Aichberger et al., 2010; Brothers et al., 2014; Ladin and Reinhold, 2013; Solé-Auró and Crimmins, 2008) by incorporating further waves of data collection. This increases the number of subjects' initial interviews available for cross-sectional analyses and permits longitudinal modelling of frailty trajectories (i.e. frailty over time) at ages over 50 years. It aims to enrich our understanding of the health issues facing an aging and expanding European migrant population to support policymakers in the strategic planning of health and social care delivery.

2. Materials and methods

2.1. Data sources and study design

SHARE is a multinational, multidisciplinary representative observational survey of health, economic factors, social and family networks in community-dwelling persons aged ≥50 years and their partners or spouses, regardless of age. Participating households contained at least one non-institutionalised member aged ≥50 years old who spoke the official language of the country and was not living abroad at the time of survey. Interviews were conducted by trained lay interviewers from professional survey agencies in respondents' homes using structured computerised questionnaires. Sampling methods varied by participant country as described in the SHARE documentation (see below). Participating countries at wave 1 (2004–2005): Austria, Belgium, Denmark, France, Germany, Greece, Israel, Italy, Netherlands, Spain, Sweden and Switzerland; at wave 2 (2006–2007): addition of Czech

Table 1
Baseline descriptors for all subjects, migrants and non-migrants.

Variable	All subjects (n = 95,635)		Migrants (n = 8704)		Non-migrants (n = 86,931)		p[c]
	n	% or med (IQR)	n	% or med (IQR)	n	% or med (IQR)	
Baseline frailty index[b]	95,635	0.14 (0.08–0.23)	8704	0.15 (0.09–0.25)	86,931	0.14 (0.08–0.22)	< 0.001
Migrant origin[a]							–
LMIC[d]-born	5299	5.75	5310	60.9	0	0.00	
HIC[e]-born	3405	3.77	3468	39.1	0	0.00	
Region of domicile[a]							< 0.001
Northern Europe	17,949	19.7	2343	26.9	15,606	17.9	
Southern Europe	19,273	23.7	531	6.10	18,742	21.6	
Eastern Europe	17,483	14.4	908	10.4	16,575	19.1	
Western Europe	40,930	42.3	4922	56.6	36,008	41.4	
Baseline age (y)[a]							< 0.001
≥50 to < 60	36,571	38.2	3473	39.9	33,098	38.1	
≥60 to < 70	30,485	31.9	2620	30.1	27,865	32.1	
≥70 to < 80	20,039	21.0	1871	21.5	18,168	20.9	
≥80	8540	8.93	740	8.50	7800	8.97	
Age at migration (y)[a]							–
≤21	4393	4.59	4393	50.5	0	0.00	
> 21	4308	4.50	4308	49.5	0	0.00	
Female[a]	52,022	54.4	4849	55.7	47,173	54.3	0.01
Baseline height (cm)[a]							< 0.001
< 160	14,968	15.7	1750	20.1	13,218	15.2	
≥160 to < 170	38,232	40.0	3480	40.0	34,752	40.0	
≥170	42,435	44.4	3474	39.9	38,961	44.8	
Education[a]							< 0.001
None or primary	23,447	24.5	1858	21.4	21,589	24.8	
Secondary	49,044	51.3	4033	46.3	45,011	51.8	
Post-secondary	23,144	24.2	2813	32.3	20,331	23.4	
Migrant stock[f,a]							< 0.001
< 5% population	13,882	14.5	505	5.80	13,377	15.4	
≥5% population	81,753	85.5	8199	94.2	73,554	84.6	
Home ownership[a]	53,356	55.8	4109	47.2	49,247	56.7	< 0.001
Household income (Euro × 1000)[b]	95,635	25.2 (12.0–50.6)	8704	24.5 (11.6–52.9)	86,931	25.3 (13.1–50.4)	< 0.01
Citizenship[a]	92,087	96.3	5463	62.8	86,624	99.7	< 0.001
Duration of citizenship (y)[b]	55,038	65.8 (58.7–73.9)	1664	23.3 (18.4–41.1)	53,374	66.1 (59.3–74.3)	
MIPEX health[a,g]							< 0.001
Top rank	36,646	38.3	2511	28.9	34,135	39.3	
Middle rank	40,103	41.9	3936	45.2	36,167	41.6	
Bottom rank	18,886	19.8	2257	25.9	16,629	19.1	
Year of migration[a]							–
< 1950	1564	1.64	1564	18.0	0	0.00	
≥1950 to < 1975	4142	4.33	4142	47.6	0	0.00	
≥1975 to < 1990	1765	1.85	1765	20.3	0	0.00	
≥1990	1233	1.29	1233	14.2	0	0.00	
Baseline time since migration (y)[a]							–
< 10	398	4.57	398	4.57	0	0.00	
≥10	8306	8.69	8306	95.4	0	0.00	
Subjects per household[a]							< 0.001
1 subject	37,747	39.5	3911	44.9	33,836	38.9	
2 subjects	57,368	60.0	4764	54.7	52,604	60.5	
≥3 subjects	520	0.54	29	0.33	491	0.57	
Data points[a]							< 0.001
1 interview	43,341	45.3	4084	46.9	39,257	45.2	
2 interviews	29,339	30.7	3238	37.2	26,101	30.0	
3 interviews	7662	8.01	462	5.31	7200	8.28	
4 interviews	7723	8.08	499	5.73	7224	8.31	

Table 1 (*continued*)

Variable	All subjects (n = 95,635)		Migrants (n = 8704)		Non-migrants (n = 86,931)		p[c]
	n	% or med (IQR)	n	% or med (IQR)	n	% or med (IQR)	
5 interviews	7570	7.92	421	4.84	7149	8.22	
TOTALS[a]							–
SUBJECTS	95,635	100	8704	100	86,931	100	
INTERVIEWS	193,747	–	15,957	–	177,700	–	
HOUSEHOLDS	66,600	–	7443	–	61,434	–	

[a] Percentage.
[b] Median (interquartile range).
[c] P-values for differences between migrants and non-migrants in characteristics at baseline interviews.
[d] Low or middle income country.
[e] High income country.
[f] Mean percentage of international migrants in the total population of the host country.
[g] Migrant Integration Policy Index IV (2014) health strand.

Table 2
Percentage differences in frailty in separate age-adjusted regression models (left column) and a regression model mutually adjusted for all confounders (right column).

	Age-adjusted models			Confounder-adjusted model		
	% difference	95% CI[a]	p	% difference[b]	95% CI	p
Migrant	12.7[c]	[11.1, 14.4]	< 0.001	16.4	[14.6, 18.2]	< 0.001
Age (y)						< 0.001
≥50 to < 60	–	–	–	–	–	
≥60 to < 70	27.0[d]	[25.5, 28.4]	< 0.001	22.2	[20.9, 23.6]	
≥70 to < 80	77.5	[75.3, 79.7]	< 0.001	62.8	[60.9, 64.8]	
≥80	153.7	[149.8, 157.6]	< 0.001	121.7	[118.4, 125.0]	
Estimate per unit change[f]	*3.1*	*[3.1, 3.1]*	*< 0.001*	*2.7*	*[2.6, 2,7]*	*< 0.001*
Female	20.5[e]	[19.5, 21.4]	< 0.001	7.4	[6.3, 8.5]	< 0.001
Height (cm)						< 0.001
< 160	–	–	–	–	–	
≥160 to < 170	−14.9[e]	[-15.9, −13.8]	< 0.001	−10.7	[-11.8, −9.6]	
≥170	−28.9	[-29.7, −28.0]	< 0.001	−19.0	[-20.2, −17.8]	
Estimate per unit change	*−1.4*	*[-1.4, -1.3]*	*< 0.001*	*−0.8*	*[-0.9, -0.8]*	*< 0.001*
Education						< 0.001
None/primary	–	–	–			
Secondary	−20.5[e]	[-21.4, −19.7]	< 0.001	−19.7	[-20.5, −18.9]	
Post-secondary	−37.3	[-38.2, −36.5]	< 0.001	−34.7	[-35.6, −34.0]	
Migrant stock[g]						< 0.001
< 5% population	–	–	–			
≥5% population	−17.0[e]	[-18.2, −15.9]	< 0.001	−17.4	[-18.4, −16.2]	
Estimate per unit change	*−0.8*	*[-0.9, -0.7]*	*< 0.001*	*−0.6*	*[-0.7, -0.5]*	*< 0.001*

[a] 95% confidence intervals.
[b] Percentage differences in frailty mutually adjusted for all confounders (age, sex, height, education, migrant stock).
[c] Percentage difference in frailty between migrants and non-migrants (adjusted for age).
[d] Percentage differences in frailty relative to the baseline age category (unadjusted).
[e] Percentage differences in frailty relative to the baseline category for each remaining confounder (from separate linear models adjusted for age).
[f] Estimate per unit change of covariate (e.g. per year increase in age) with associated test for trend p-value.
[g] Mean percentage of international migrants in the total population of the host country.

Republic, Ireland and Poland; at wave 3 (2008–2009): withdrawal of Ireland and Israel; at wave 4 (2011–2012): addition of Estonia, Hungary, Portugal and Slovenia and withdrawal of Greece; at wave 5 (2013): addition of Luxembourg and withdrawal of Hungary, Poland and Portugal. Individual response rates published for wave 1 ranged from 73.7% in Spain to 93.3% in France. Household response rates varied between 38.8% in Switzerland to 81.0% in France. Online Resource 1 describes sample size and wave-on-wave retention by country and demonstrates by comparing the weighted proportion of elderly migrants in SHARE with official country statistics that this group is likely under-represented in the dataset. This study utilised anonymised individual-level data from SHARE waves 1 (Börsch-Supan, 2013a; Börsch-Supan et al., 2013; Börsch-Supan and Jürges, 2005), 2 (Börsch-Supan, 2013b; Börsch-Supan et al., 2008), 3 (Börsch-Supan, 2010; Börsch-Supan and Schröder, 2011), 4 (Abduladze et al., 2013; Börsch-Supan, 2013c) and 5 (Börsch-Supan, 2015; Malter and B.-S., 2015). We retained a final study sample as described in Fig. 1 which included 95,635 unique individuals from 66,600 households who participated in 193,747 interviews.
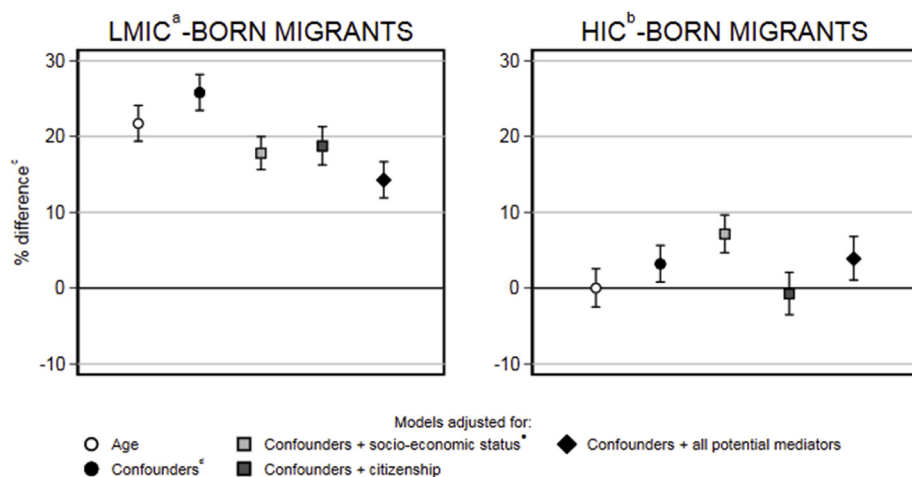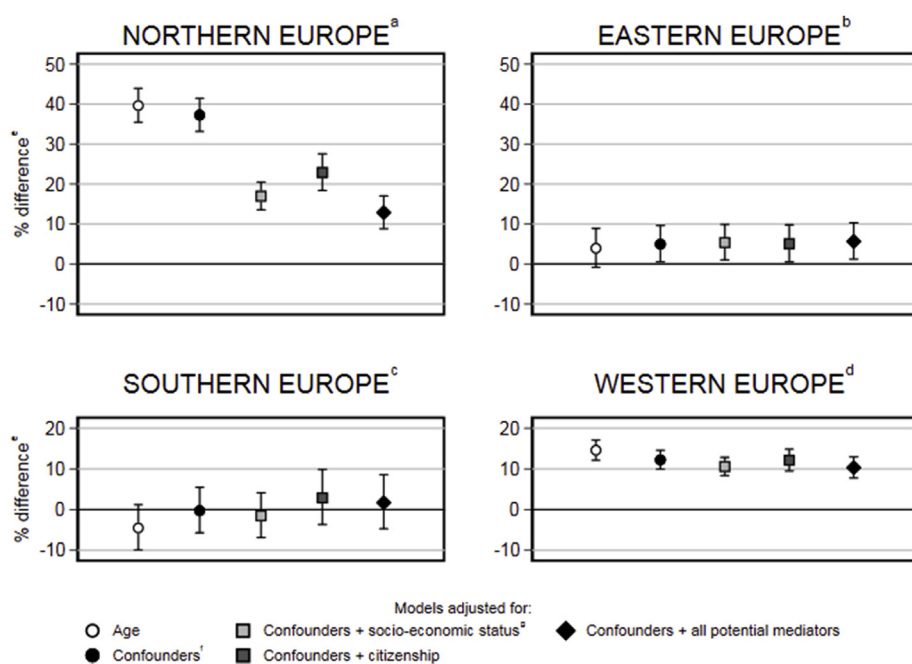
Fig. 2. Association between migration and frailty in models adjusting for confounders and potential intermediaries stratified on high and low or middle income country of origin.
[a] Low or middle income country.
[b] High income country.
[c] Percentage difference in frailty in migrants versus non-migrants from linear models with 95% confidence intervals.
[d] Confounders: age, gender, height, education, proportion of international migrants in the host country population.
[e] Socio-economic status: home ownership, household income.

Fig. 3. Association between migration and frailty in models adjusting for confounders and potential intermediaries stratified on European region of domicile.
[a] Northern Europe: Denmark, Estonia, Ireland and Sweden.
[b] Eastern Europe: Czech Republic, Hungary and Poland.
[c] Southern Europe: Greece, Italy, Portugal, Slovenia and Spain.
[d] Western Europe: Austria, Belgium, France, Germany, Luxembourg, Netherlands and Switzerland.
[e] Percentage difference in frailty in migrants versus non-migrants from linear models with 95% confidence intervals.
[f] Confounders: age, gender, height, education, proportion of international migrants in the host country population.
[g] Socio-economic status: home ownership, household income.

2.2. Migrant status, host and origin exposures

First-generation migrants were defined as individuals who reported being born outside their current country of domicile in SHARE. Using similar methods to Brothers et al. (2014), we grouped migrants into having originated from LMIC or HIC according to their country of birth using the World Bank Analytical Classification and taking the modal group over 1987–2013 (World Bank, 2014). Age at migration and time since migration were derived from self-reported year of migration. We classified their destinations into Northern, Western, Eastern and Southern Europe as per United Nations definitions (United Nations Statistics Division, 2015) but re-coded Slovenia from Southern to Eastern Europe for the purposes of studying migration.

2.3. Outcome: frailty indices

Frailty indices (FI) were based on 60 of the 70 health deficits (symptoms, signs, diseases and physical, cognitive, behavioural and psychological impairments) used by Pena et al. (2014) that were available longitudinally over the SHARE timeline and are listed in Online Resource 2. After Pena et al. (2014), we mapped deficits onto a 0 (absent) to 1 (present) scale (a) with as many deficits as possible coded

as ordinal (graded severity of deficit) in the 'ordinal' coding scheme and (b) only dichotomous values in the 'dichotomous' coding scheme. FI scores were derived by summating an individual's mapped deficits and dividing by the number of deficits recorded. Frailty indices were coded as missing at wave 3 (23,846 interviews) where health deficits were not measured and in 2758 other interviews where > 20% of deficits were missing. FI scores were log-transformed and entered as a continuous variable into regression and multilevel models so that residuals were approximately normally distributed.

2.4. Potential confounders

The following were considered to be potential confounders: age group (≥ 50 to < 60, ≥ 60 to < 70, ≥ 70 to < 80 and ≥ 80 years), gender (female versus male), height (proxy for adverse early life pre-migration exposures; < 160, ≥ 160 to < 170 and ≥ 170 centimetres), education (proxy for pre-migration SES) and the existing migrant population based on the United Nations host country migrant stock data (< 5, $\geq 5\%$ of host country population) (United Nations, 2013). Peak educational attainment was categorised into three tiers based on International Standard Classification of Education (ISCED) 1997 codes: none, pre-primary or primary education (ISCED 0, 1), lower or upper
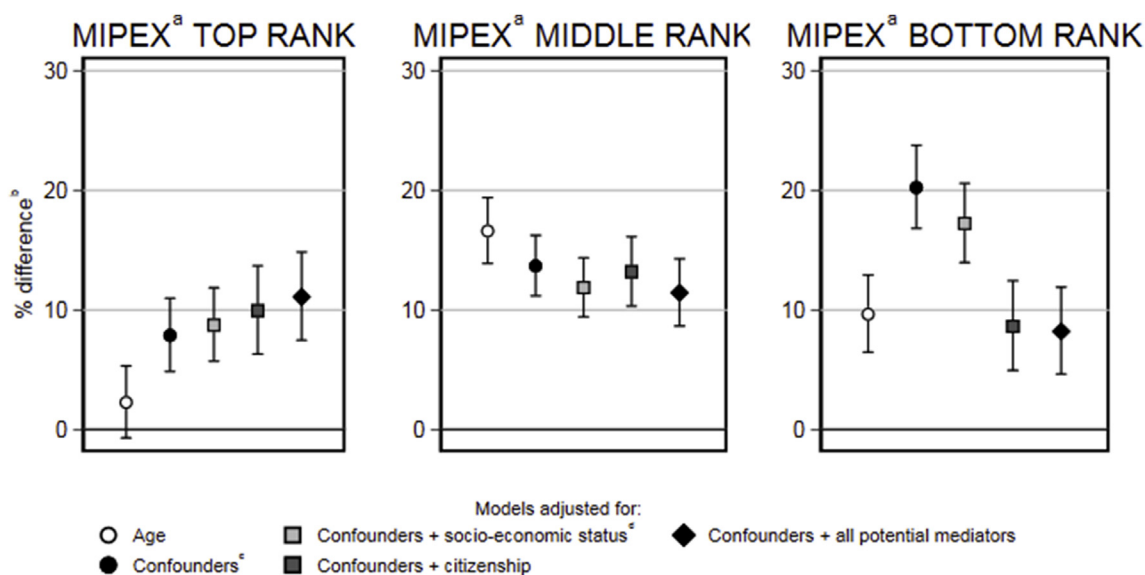
Fig. 4. Association between migration and frailty in models adjusting for confounders and potential intermediaries in categories of the Migrant Integration Policy Index (MIPEX) health strand.

[a] Migrant Integration Policy Index (MIPEX) IV (2014) (Huddleston et al., 2015) health strand tertile rank ('top rank' being most inclusive; 'bottom rank' being least inclusive).

[b] Percentage difference in frailty in migrants versus non-migrants from linear models with 95% confidence intervals.

[c] Confounders: age, gender, height, education, proportion of international migrants in the host country population.

[d] Socio-economic status: home ownership, household income.

secondary education (ISCED 2, 3) or post-secondary education i.e. tertiary or post-secondary non-tertiary education (ISCED 4–6).

2.5. Potential mediators

Home ownership and quintiles of household income (measures of adult/post-migration SES) and citizenship (both a marker of migrant acculturation and of legal status (Riosmena et al., 2015)) were considered to be potential mediators of the association between migrant status and frailty.

2.6. Subgroup analyses

We postulated *a priori* that the effect of migration on frailty may be modified by country of origin, both in terms of geography and economic development, and host country policy to make health care accessible to migrants. We therefore assessed whether associations between migrant status and frailty differed in the following subgroups: (i) LMIC- and HIC-born migrants, (ii) Residents of Northern, Southern, Eastern and Western European countries, (iii) Tertiles (1 being most inclusive; 3 being least inclusive) of the Migrant Integration Policy Index (MIPEX) IV (2014) (Huddleston et al., 2015) health strand – a proxy of healthcare coverage and access which is described in Online Resource 2. Interactions were formally tested using likelihood ratio tests.

2.7. Statistical analyses

2.7.1. Cross-sectional associations of migration with frailty at baseline interviews

Cross-sectional modelling of the association between migration status and frailty used data from subjects' initial interviews. Multiple linear regression models were fitted to estimate differences in frailty between migrants and non-migrants accounting for clustering at the household level. We assessed the following regression models: (i) unadjusted; (ii) adjusted for age and each potential confounder separately (listed above); (iii) adjusting for all potential confounders; (iv)

additionally adjusting for each potential mediator separately (listed above); (v) fully adjusted for all potential confounders and mediators. Confounders and potential mediators were assumed to have the same effect on outcome irrespective of migrant status, since exploratory analyses provided no evidence for such interactions. Regression coefficients were exponentiated and are interpreted as the percentage difference in FI score in migrants compared to non-migrants. We derived crude estimates of excess hazard of death associated with differences on the FI score, based on the work of Romero-Ortuno and Kenny (2012) to highlight the public health relevance of these variations.

2.7.2. Associations of migration with trajectories of frailty at ages over 50

Individual trajectories of log FI from age 50 years were estimated using random effects multilevel models, fitted in MLwiN v2.28 using the Stata (*StataCorp*, College Station, Texas) command 'runmlwin' (Leckie and Charlton, 2013; Rasbash et al., 2013). Random intercepts and random slopes were permitted and log frailty trajectories were modelled using an age and age^2 term. They were estimated for all participants with at least one measure of log frailty and all measures of the included covariates under a missing at random assumption. Full model details are provided in Online Resource 3. An interaction term was included to estimate the difference in log FI trajectories between migrants and non-migrants. The difference in log FI between migrants and non-migrants at ages 50, 60, 70, 80, 90 and 100 years was estimated and Z-tests were used to assess the statistical evidence for these differences. Mean differences in log FI were exponentiated to give a ratio of geometric means, thus, results are interpreted as a percent difference in FI score in migrants compared to non-migrants.

2.8. Sensitivity analyses

We compared results from our main analysis in which the 'ordinal' FI coding was used, to those in which the alternative 'dichotomous' FI coding scheme was used (Online Resource 2) (Peña et al., 2014). We also examined the effect of the following alternative MIPEX (Citron and Gowan, 2005; Huddleston et al., 2015; Niessen, 2007; Huddleston et al., 2011) tertile ranks on our subgroup analyses as detailed in Online

Table 3

Regression models for the association between migration and frailty adjusting for age, confounders and potential intermediaries.

	% difference.[a]	95% CI[b]	p
Age-adjusted model			
Migrant	12.7	[11.0, 14.4]	< 0.001
Confounder-adjusted model[c]			
Migrant	16.4	[14.6, 18.2]	< 0.001
Adjusted for confounders + socio-economic status[d]			
Migrant	13.5	[11.8, 15.2]	< 0.001
Home owner	−5.0	[-5.7, −4.2]	< 0.001
Household income			
1st quintile	–	–	–
2nd quintile	−12.5	[-13.7, −11.2]	< 0.001
3rd quintile	−19.9	[-21.0, −18.7]	< 0.001
4th quintile	−25.7	[-26.7, −24.5]	< 0.001
5th quintile	−30.6	[-31.7, −29.6]	< 0.001
Adjusted for confounders + citizenship			
Migrant	12.1	[10.1, 14.1]	< 0.001
Citizen	−9.7	[-12.2, −7.2]	< 0.001
Adjusted for confounders + all potential mediators			
Migrant	11.0	[9.1, 12.9]	< 0.001
Home owner	−4.9	[-5.7, −4.2]	< 0.001
Household income			
1st quintile	–	–	–
2nd quintile	−12.3	[-13.5, −11.1]	< 0.001
3rd quintile	−19.7	[-20.8, −18.5]	< 0.001
4th quintile	−25.5	[-26.6, −24.4]	< 0.001
5th quintile	−30.5	[-31.5, −29.5]	< 0.001
Citizen	−6.0	[-8.5, −3.4]	< 0.001

[a] Percentage difference in frailty in migrants versus non-migrants from linear models.

[b] 95% confidence interval.

[c] Confounders: age, gender, height, education, proportion of international migrants in the host country population.

[d] Socio-economic status: home ownership, quintiles of household income (1st quintile: bottom 20%; 5th quintile: top 20%).

Resource 2: (i) MIPEX labour market mobility strand (a proxy of workers' rights and access to training, education and employment); (ii) 'five-strand average' MIPEX (a broad proxy of migrant integration in multiple dimensions). To explore possible selection bias by differential loss to follow-up, we examined associations in subjects who contributed one and two-or-more observations. We also examined whether loss to follow-up (defined as only single-wave participation throughout SHARE waves 1–4) was predicted by migrant status and frailty at baseline interview.

2.9. Post hoc analyses

Further analyses were conducted to assess whether associations were similar in (i) males who migrated after 1949, to examine a more homogenous group of labour migrants (Ladin and Reinhold, 2013) and (ii) those who lived in the host country for ≤10 years to investigate the effect of migrant acculturation. As will be shown below in the results section, Southern Europe was unique in that the direction of association between migration and frailty was opposed to those of other

geographical areas. To test whether this inconsistency was more attributable to the Southern European migrant population or the comparator host population, we compared frailty in Southern European migrants versus Northern European migrants. Finally, we explored whether duration of citizenship might explain associations between migration status and frailty.

3. Results

3.1. Descriptive analyses of baseline interviews

The sample comprised 86,931 non-migrants (90.9%) and 8704 migrants (9.1%). 54.2% were female and median age was 63.3 (interquartile range; IQR: 56.3, 71.8) years. Within the migrant population, 5299 (60.8%) were born in LMIC and 3405 (39.1%) in HIC. Migrants at baseline (Table 1) were significantly younger and more educated but shorter, less often home owners or citizens in their host country and had reduced household income compared to non-migrants. Migrants were frailer than non-migrants at baseline: unadjusted median FI score 0.15 (IQR: 0.09, 0.25) versus 0.14 (IQR: 0.08, 0.22), p < 0.001.

Of the migrant population, 2343 (26.9%), 531 (6.1%), 908 (10.4%) and 4922 (56.5%) were resident in Northern, Southern, Eastern and Western Europe, respectively (Online Resource 4). The proportion of migrants born within Europe varied from 23.4% in Southern and 50.1% in Western Europe to 79.9% in Northern and 80.5% in Eastern Europe. Unadjusted non-migrant FI scores were greater in Southern (0.15 [IQR: 0.09, 0.25]) and Eastern Europe (0.16 [IQR: 0.10, 0.26]) compared to Northern (0.12 [IQR: 0.07, 0.21]) and Western Europe (0.13 [IQR: 0.08, 0.20]), p < 0.001. In contrast, unadjusted migrant FI scores were greater in Northern (0.19 [IQR: 0.11, 0.31]) and Eastern Europe (0.17 [IQR: 0.10, 0.27]) compared to Southern (0.13 [IQR: 0.08, 0.20]) and Western Europe (0.14 [IQR: 0.09, 0.23]), p < 0.001. MIPEX healthcare ranking was highest in Austria, Ireland, Italy, Netherlands, Spain, Sweden and Switzerland; intermediate in Belgium, Czech Republic, Denmark, France, Germany, Luxembourg and Portugal; and lowest in Estonia, Greece, Hungary, Poland and Slovenia. Unadjusted non-migrant FI scores increased with worsening healthcare access and coverage: 0.13 (IQR: 0.08, 0.21), 0.14 (IQR: 0.08, 0.22) and 0.17 (IQR: 0.10, 0.28) in MIPEX healthcare top-, middle- and bottom-ranking countries, respectively. This trend was also evident in migrant FI scores: 0.12 (IQR: 0.08, 0.20), 0.15 (IQR: 0.09, 0.25) and 0.20 (IQR: 0.12, 0.32) in top-, middle- and bottom-ranking countries, respectively.

3.2. Cross-sectional analyses of baseline interviews

European migrants were on average 16.4% (95% CI: 14.6, 18.2%) frailer than non-migrants, even after adjustment for age and all potential confounders (Table 2 and Online Resource 5). Chronological age strongly predicted frailty. Women were frailer than men, but after adjustment for age and other confounders this was markedly attenuated. Taller height and higher levels of education were associated with reduced frailty. FI scores were lower in populations comprising ≥5% migrants. Home ownership and higher household income (proxies of post-migration SES) and host country citizenship (a proxy of migrant acculturation) were protective.

Subgroup analyses for LMIC- and HIC-born migrants (Fig. 2 and Online Resources 6 and 7) identified discordant associations between migration and frailty in each group (p < 0.001). LMIC-born migrants' confounder-adjusted FI scores were on average 25.8% (95% CI: 23.4, 28.2%) greater than non-migrants but HIC-born migrants' scores were only 3.2% (95% CI: 0.8, 5.6%) greater (interaction p < 0.001).

Relationships between migration and frailty were also heterogeneous across European regions of domicile (Fig. 3 and Online Resources 8–11) (interaction p < 0.001). In Northern, Western and Eastern Europe, migrants were 37.3% (95% CI: 33.2, 41.5%), 12.2% (95% CI: 10.0, 14.6%) and 5.0% (95% CI: 0.5, 9.6%) frailer than non-
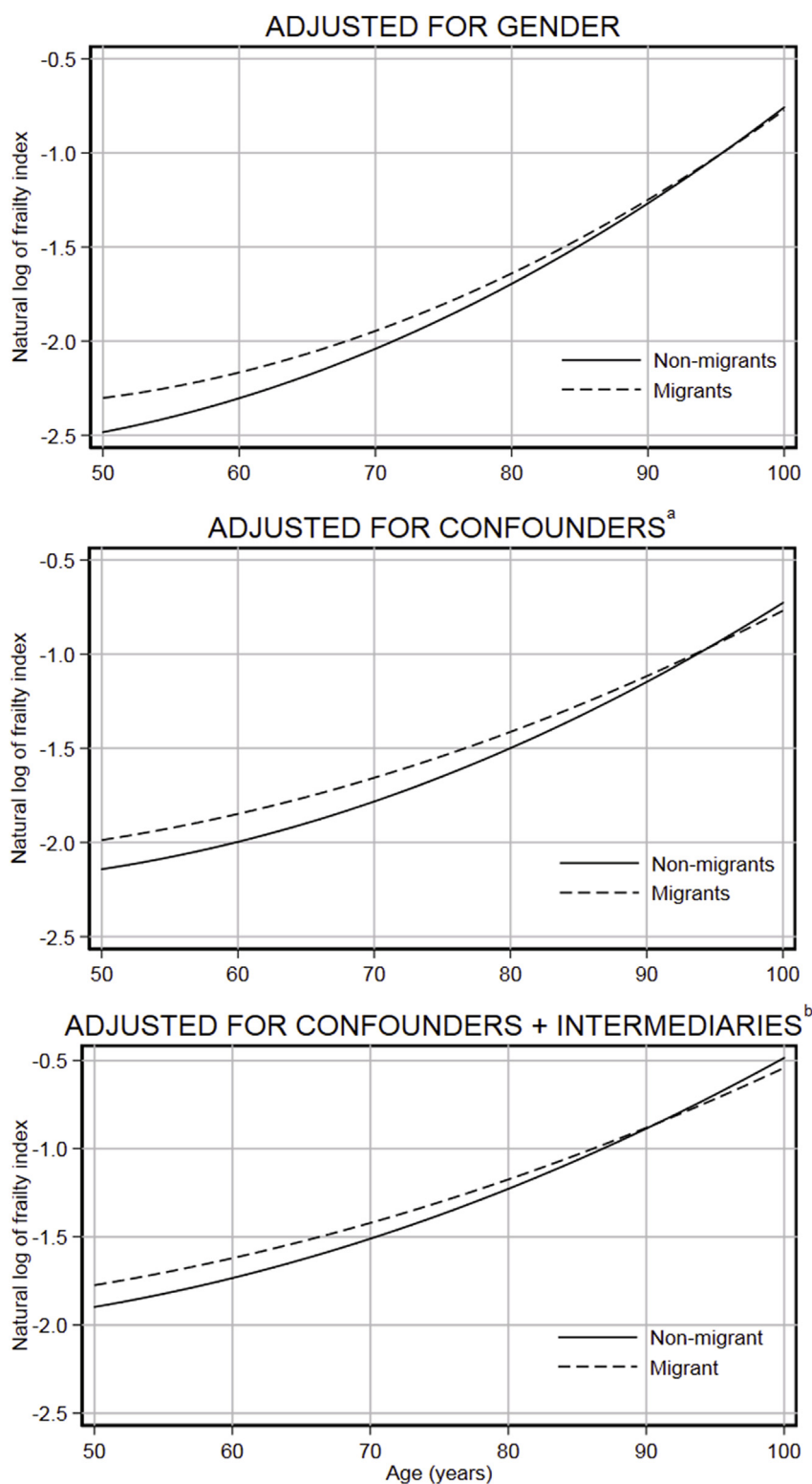
Fig. 5. Migrant and native-born frailty trajectories throughout older age adjusting for confounders and potential intermediaries.
[a] Confounders: age, gender, height, education, proportion of international migrants in the host country population.
[b] Confounders, home ownership, household income, citizenship and Migrant Integration Policy Index IV (2014) health strand.

migrant comparators after confounder adjustment, respectively. These correspond to a 31.4% (95% CI: 27.6, 35.5%), 8.8% (95% CI: 6.9, 10.6%) and 3.5% (95% CI: 0.2, 7.0%) increase in the hazard of death in SHARE (Romero-Ortuno and Kenny, 2012), respectively. In contrast, in Southern Europe confounder adjustment fully attenuated any migrant effect to −0.3% (95% CI: −5.7, 5.5%), p = 0.923. Country-level

descriptions are provided in Online Resource 12.

Associations between migration and increased frailty strengthened with decreasing performance of the host country in the MIPEX healthcare ranking (Fig. 4 and Online Resources 13–15), p < 0.001. Migrants were a respective 7.9% (95% CI: 4.9, 11.0%), 13.7% (95% CI: 11.2, 16.2%) and 20.2% (95% CI: 16.8, 23.8%) frailer than non-

Table 4
Percentage differences in frailty between migrants and non-migrants throughout older age adjusting for confounders and potential intermediaries.

Frailty at age (y)	Gender-adjusted			Confounder-adjusted[a]			Fully adjusted[b]		
	% difference	95% CI[c]	p	% difference	95% CI	p	% difference	95% CI	p
50	18.1	14.5–21.8	< 0.001	15.4	11.8–19.1	< 0.001	12.4	8.1–16.6	< 0.001
60	13.7	12.0–15.4	< 0.001	14.8	13.1–16.5	< 0.001	11.3	9.2–13.3	< 0.001
70	9.5	7.6–11.4	< 0.001	12.6	10.6–14.5	< 0.001	8.9	6.7–11.1	< 0.001
80	5.5	3.3–7.8	< 0.001	8.6	6.4–10.9	< 0.001	5.3	2.8–7.8	< 0.001
90	1.9	−3.2–7.0	0.475	3.1	−2.1–8.2	0.094	0.5	−5.2–6.1	0.876
100	−1.5	−12.4–9.3	0.783	−0.4	−15.0–6.6	0.926	−5.7	−17.7–6.3	0.351

[a] Confounders: age, gender, height, education, proportion of international migrants in the host country population.
[b] Confounders, home ownership, household income and citizenship.
[c] 95% confidence interval.

migrants after adjusting for confounders in top-, middle- and bottom-ranked countries (interaction p < 0.001). This did not explain the Southern European 'healthy migrant' effect.

Results of intermediary-adjusted models are presented in Table 3 (Europe-wide), Fig. 2 (LMIC- and HIC-born migrants), Fig. 3 (regional models), Fig. 4 (within MIPEX categories) and Online Resources 5–11 and 13–15. SES did not explain migrant versus non-migrant differences in frailty in any analysis. Adjustment for citizenship reduced the migrant frailty burden from 16.4% (95% CI: 14.6, 18.2%) to 12.1% (95% CI: 10.1, 14.1%) at European level, with marked attenuation for LMIC-born migrants, HIC-born migrants and within Northern Europe. Citizenship also attenuated the migrant effect in countries of bottom MIPEX healthcare ranking such that the migrant effect no longer varied by MIPEX category after adjustment for citizenship (interaction p = 0.20).

3.3. Multilevel longitudinal models of frailty trajectories

We present Europe-wide frailty trajectories in Fig. 5 and percentage differences in frailty between migrants and non-migrants in Table 4. After confounder adjustment, migrants were frailer than non-migrants by 15.4% (95% CI: 11.8, 19.1%) at age 50 years (p < 0.001). We observed that the Europe-wide migrant sample accumulated frailty at a slower rate than non-migrant comparators such that frailty trajectories converged, becoming indistinct between ages 80 and 90 years. Adjustment for potential intermediaries reduced the frailty inequality and accelerated the convergence of migrant and non-migrant frailty trajectories.

Frailty trajectories in migrants and non-migrants were assessed within subgroups of country of birth income classification, European region of domicile and host country MIPEX healthcare ranking (Online Resources 19 and 20). Results were consistent with the cross-sectional analyses. With the exception of Southern Europe, migrants were consistently frailer than non-migrants. Frailty differences between migrants and non-migrants were especially large for LMIC-born and Northern European migrants.

3.4. Sensitivity and post hoc analyses

Sensitivity analyses demonstrated that our conclusions may be more conservative than if 'dichotomous' FI coding had been utilised (Online Resource 17). Associations between migration and frailty were altered when subgroups based on the MIPEX five-strand average (as an overall proxy for the inclusivity of host country policies towards migrants) and the MIPEX labour market mobility ranking (as a proxy of migrant workers' rights and access to training, education and employment) were employed (Online Resource 18). For both descriptors, in comparison to MIPEX healthcare categories, the migrant frailty burden was smaller in bottom-ranking countries and higher in top-ranking countries.

Migrants exhibited a different pattern of SHARE wave participation to non-migrants (Table 1) but our findings were unchanged by

restriction to single-wave or multi-wave participants (Online Resource 17). Frailty predicted loss to follow-up (p < 0.001). Migrants were 6.2% less likely to be lost to follow-up than natives (p = 0.03). However, migration did not interact with frailty to predict loss to follow-up (p = 0.34).

Restricting the migrant sample to the 3156 men who migrated after 1949 (likely to be a more homogeneous group of labour migrants) did not alter our results (Online Resource 16). We found that the 399 migrants who enrolled in SHARE ≤10 years after migration (median 5.8 [IQR: 3.8, 7.7] years) were no more or less frail than natives after confounder-adjustment (−1.9% [95% CI: −9.0, 5.8%]), p = 0.62 (Online Resource 16). This may suggest that the migrant frailty burden develops with acculturation but is conditioned by citizenship and healthcare access. To investigate the contributions of migrant and host frailty to the 'healthy migrant effect' detected in Southern Europe, we found that Southern European migrants were 18.8% (95% CI: 14.2, 23.1%) less frail than Northern European migrants after confounder adjustment (p < 0.001), supporting the theory that Southern European migrants' reduced frailty is a function of migrants to Southern Europe rather than the specific host population.

Data concerning duration of citizenship were incomplete (Table 1). However, analyses restricted to the 57.6% of persons with data demonstrated that migrants were 10.2% (95% CI: 8.4, 12.0%) frailer than non-migrants after adjustment for confounders and citizenship. Additional control on duration of citizenship reduced this to 6.1% (95% CI: 4.1, 8.0%), p < 0.001.

4. Discussion

This is one of the largest studies to examine the impact of migration on older age frailty. Overall, we found that migrants were frailer than non-migrant counterparts and these differences were not fully accounted for by confounding factors. We observed marked heterogeneity both by the geographical region to which they migrated and the level of economic development of the countries of origin. LMIC-born migrants were far frailer than HIC-born migrants, consistent with the findings of Brothers et al. (2014). This is likely to reflect the worse early life environment that such migrants experienced pre-migration and would be consistent with theories of ageing such as 'antagonistic pleiotropy', which postulate that biological investment in early growth and development comes at the expense of later repair and regeneration. Genetic factors or an interaction between genes and environment may also play a role. LMIC-born migrants may also suffer greater barriers to socioeconomic mobility, naturalisation or healthcare access than HIC-born migrants in Europe's host countries (Rechel et al., 2013).

Frailty trajectories converged over the life course so that by 80–90 years old there were no migrant versus non-migrant differences. This could reflect the more deleterious adult life style exposures experienced by non-migrants and/or a stronger healthy survivor effect seen in migrants. Another possibility is the 'unhealthy re-migration effect' (49,

50), a survivorship bias in which migrants return to their country of origin to die, leaving an apparently healthier migrant population in the host country.

Mortality data ascertained from official sources and by re-contacting households between SHARE waves 1 and 2 demonstrate that death rates that are no different between migrants and non-migrants (Brothers et al., 2014). Convergence of frailty trajectories in the present study is therefore unlikely to be explained by drop-out bias i.e. migrants being more likely to die than non-migrants at equal levels of frailty, leaving the most healthy migrants alive by age 80–90 years.

Whilst we observed that Northern, Western and Eastern European migrants were frailer than non-migrants, Southern European migrants were no more or less frail than non-migrants. This could have been because South European non-migrants, as the comparator, were themselves frailer but in our sensitivity analysis we found the same pattern of results when we compared the South European migrants to a North European migrants, indicating that this reflects a greater health selection effect for those individuals who choose to migrate to Southern Europe – in the past more frequently fleeing conflict, war and economic crises (Massey, 1990; Salt, 2005). This is consistent with studies which have considered functional outcomes in Greece, Italy and Spain (Solé-Auró and Crimmins, 2008); chronic disease burden in Greece and Italy (Solé-Auró and Crimmins, 2008) and depression in Southern Europe (Aichberger et al., 2010). Our larger sample size allowed us to extend the observation of Brothers et al. (2014), who reported that migrants were no frailer than non-migrants in a pooled Eastern and Southern European sample, by demonstrating that this was only true in Southern Europe. Not all analyses have found this; for example more chronic disease was reported burden in Spanish migrants (Solé-Auró and Crimmins, 2008) and greater rates if depression has been seen in migrants to Greece, Italy and Spain (Ladin and Reinhold, 2013). Though 9 of the 60 items in the frailty index related to psychiatric symptoms, the overall FI may not adequately capture the burden of psychological morbidity. The possibility of under-reporting of health outcomes and the 'unhealthy re-migration effect' could also explain our findings in Southern Europe.

Migrants are frequently found to be healthier and exhibit lower mortality rates than non-migrants (Angel et al., 2010; Hummer et al., 1999; Rechel et al., 2013). Our findings may therefore appear paradoxical but contribute to a growing literature which finds little evidence of the 'healthy migrant' in later life in Europe (Aichberger et al., 2010; Brothers et al., 2014; Ladin and Reinhold, 2013; Solé-Auró and Crimmins, 2008). It remains possible that any 'healthy migrant' signal in early post-migration life (median age of migration was 21 [IQR: 13, 30] year old) was eroded before enrolment in SHARE due to mortality or acculturation (Wakabayashi, 2010).

As well as individual-level factors, we also observed potential structural factors that appeared to modify migrant risk. Countries with policies that enhanced migrant health access, as measured by MIPEX health, showed less frailty for migrants compared to the non-migrants, suggesting that this may be mediated by potential barriers to healthcare access. Unfamiliarity with host country healthcare systems and reduced ability to navigate alternative routes of healthcare access may explain this. Adjustment for individual citizenship not only attenuated the frailty differences but also reduced the structural effect modification of health care access, implying that this effect can be reduced by obtaining equal legal rights to non-migrants. *Post hoc* analyses suggested that increasing duration of citizenship may be additionally protective.

In agreement with other studies (Brothers et al., 2014; Santos-Eggimann et al., 2009; Theou et al., 2013), whole-population FI scores were greater in Southern and Eastern Europe than Northern and Western Europe. This likely reflects the relative economic growth, political stability and success of health policy and healthcare delivery in improving life expectancies in the latter regions over the lifetime of the study participants (Mackenbach et al., 2013).

4.1. Strengths and limitations

This is a large study based on 95,635 older age Europeans providing statistical power to look for heterogeneity by geographical regions, migrant economic origins and levels of healthcare policy inclusivity. The use of both cross-sectional and longitudinal analyses allows us to have greater insight into the natural history of frailty between the migrant and non-migrant groups.

We had little data on pre-migration variables, other than height and education, or the reasons for migration to differentiate economic migrants, health tourists, refugees and asylum seekers. The effect of residual confounding by pre-migration and selection factors which are likely to favour a healthy, upwardly mobile migrant would be to attenuate the observed associations, suggesting the true associations may be even stronger. In addition, migrants may actively select host countries on the basis of liberal health care access policies, though this bias could operate in either direction so that healthier or less healthy migrants choose the most accessible countries.

It is possible that migrants may have been more likely to report morbidity. However, self-reported diagnoses often closely reflect medical records regardless of advancing age, increasing co-morbidity, poor cognition or education (Simpson et al., 2004). Furthermore, it has been shown that frailty indices are well aligned with self-perceived health (Solé-Auró and Crimmins, 2008) and predict mortality better than chronological age in different populations (Arnold et al., 2010; Romero-Ortuno and Kenny, 2012).

There could have also been differential loss to follow-up between migrants and non-migrants either due to death, non-response or 'unhealthy re-migration' (49, 50). Brothers et al. (2014) reported that short-term death rates were no different between non-migrants and different migrant groups. Our *post hoc* analyses found that restriction to single-versus multi-wave participants did not alter our results. Furthermore, we found no evidence that migration interacted with frailty to predict loss to follow-up.

The generalisability of the SHARE migrant population is also an issue. Underrepresentation of undocumented migrants, transient workers, trafficked persons, refugees and asylum seekers may have biased our results towards the null as these groups have the least access to citizenship and healthcare and the greatest vulnerability to negative health outcomes, a particular issue in Southern Europe, which is reported to host the largest populations of undocumented migrants (Carta et al., 2005).

5. Conclusion

This study has highlighted the potential increased burden of frailty in the older migrant population. These differences are modifiable to some degree by the post-migration experience including adequate access to health care. Ideally one should establish migrant specific cohorts with a focus on collecting pre-migration variables as well as better capturing the migration experience and post-migration acculturation with both self-reported and objective outcome measures. Our findings provide evidence in supporting policies that promote migrant-inclusive healthcare policies and citizenship rights as potential solutions to the growing healthcare needs of this population in Europe.

Declaration of interest

Conflicts of interest: None.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.socscimed.2018.07.033.

References

Abduladze, L., Malter, F., Börsch-Supan, A., 2013. SHARE Wave 4: Innovations & Methodology. Munich center for the economics of aging.

Aichberger, M., Schouler-Ocak, M., Mundt, A., Busch, M., Nickels, E., Heimann, H., et al., 2010. Depression in middle-aged and older first generation migrants in Europe: results from the survey of health, ageing and retirement in Europe (SHARE). Eur. Psychiatr. 25 (8), 468–475.

Angel, R.J., Angel, J.L., Venegas, C.D., Bonazzo, C., 2010. Shorter stay, longer life: age at migration and mortality among the older Mexican-origin population. J. Aging Health 0898264310383567.

Arnold, M., Razum, O., Coebergh, J.-W., 2010. Cancer risk diversity in non-western migrants to Europe: an overview of the literature. Eur. J. Canc. 46 (14), 2647–2659.

Börsch-Supan, A., 2010. Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 3 – SHARELIFE. Release Version: 1.0.0. SHARE-ERIC. 10.6103/SHARE.w3. 100.

Börsch-Supan, A., 2013a. Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 1. Release Version: 2.6.0. SHARE-ERIC. 10.6103/SHARE.w1.260.

Börsch-Supan, A., 2013b. Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 2. Release Version: 2.6.0. SHARE-ERIC. 10.6103/SHARE.w2.260.

Börsch-Supan, A., 2013c. Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 4. Release Version: 1.1.1. SHARE-ERIC. 10.6103/SHARE.w4.111.

Börsch-Supan, A., 2015. Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 5. Release Version: 1.0.0. SHARE-ERIC. 10.6103/SHARE.w5.100.

Börsch-Supan, A., Brandt, M., Hunkler, C., Kneip, T., Korbmacher, J., Malter, F., et al., 2013. Data resource profile: the survey of health, ageing and retirement in Europe (SHARE). Int. J. Epidemiol dyt088.

Börsch-Supan, A., Brugiavini, A., Jürges, H., Kapteyn, A., Mackenbach, J., Siegrist, J., et al., 2008. First Results from the Survey of Health, Ageing and Retirement in Europe (2004-2007). Starting the Longitudinal Dimension. MEA, Mannheim.

Börsch-Supan, A., Jürges, H., 2005. The Survey of Health, Aging, and Retirement in Europe. Methodology. Mannheim Research Institute for the Economics of Aging, Mannheim.

Börsch-Supan, A., Schröder, M., 2011. Retrospective data collection in the survey of health, ageing and retirement in Europe. SHARELIFE Methodol. 5.

Brothers, T.D., Theou, O., Rockwood, K., 2014. Frailty and migration in middle-aged and older Europeans. Arch. Gerontol. Geriatr. 58 (1), 63–68.

Carta, M.G., Bernal, M., Hardoy, M.C., Haro-Abad, J.M., 2005. Migration and mental health in Europe (the state of the mental health in Europe working group: appendix 1). Clin. Pract. Epidemiol. Ment. Health 1 (1), 13.

Casale-Martínez, R.I., Navarrete-Reyes, A.P., Ávila-Funes, J.A., 2012. Social determinants of frailty in elderly Mexican community-dwelling adults. J. Am. Geriatr. Soc. 60 (4), 800–802.

Citron, L., Gowan, R., 2005. European Civic Citizen Inclusion Index 2004. Retrieved from: http://www.migpolgroup.com/portfolio/european-civic-citizenship-and-inclusion-index/.

Etman, A., Burdorf, A., Van der Cammen, T.J., Mackenbach, J.P., Van Lenthe, F.J., 2012.

Socio-demographic determinants of worsening in frailty among community-dwelling older people in 11 European countries. J. Epidemiol. Community Health 66 (12), 1116–1121.

Giannoni, M., Franzini, L., Masiero, G., 2016. Migrant integration policies and health inequalities in Europe. BMC Publ. Health 16 (1), 463.

Gobbens, R.J., van Assen, M.A., Luijkx, K.G., Wijnen-Sponselee, M.T., Schols, J.M., 2010. Determinants of frailty. J. Am. Med. Dir. Assoc. 11 (5), 356–364.

Huddleston, T., Bilgili, Ö., Joki, A.-L., Vankova, Z., 2015. Migrant Integration Policy Index 2015. Retrieved from: http://mipex.eu/sites/default/files/downloads/files/mipex-2015-book-a5.pdf.

Huddleston, T., Niessen, J., Chaoimh, E.N., White, E., 2011. Migrant Integration Policy Index 2010. Retrieved from: http://www.mipex.eu/sites/default/files/downloads/migrant_integration_policy_index_mipexiii_2011.pdf.

Hummer, R.A., Rogers, R.G., Nam, C.B., LeClere, F.B., 1999. Race/ethnicity, nativity, and US adult mortality. Soc. Sci. Q. 136–153.

Kennedy, S., Kidd, M.P., McDonald, J.T., Biddle, N., 2015. The healthy immigrant effect: patterns and evidence from four countries. J. Int. Migrat. Integrat. 16 (2), 317–332.

Koser, K., Laczko, F., 2010. World Migration Report 2010. The Future of Migration: Building Capacities for Change. IOM: International Organization for Migration, Geneva, Switzerland.

Laczko, F., Appave, G., 2013. World migration report 2013. In: Migrant Well-being and Development. IOM, Geneva.

Ladin, K., Reinhold, S., 2013. Mental health of aging immigrants and native-born men across 11 European countries. J. Gerontol. B Psychol. Sci. Soc. Sci gbs163.

Leckie, G., Charlton, C., 2013. Runmlwin - a program to run the MLwiN multilevel modelling software from within Stata. J. Stat. Software 52 (11) 1–40s.

Levers, M.J., Estabrooks, C.A., Ross Kerr, J.C., 2006. Factors contributing to frailty: literature review. J. Adv. Nurs. 56 (3), 282–291.

Mackenbach, J.P., Karanikolos, M., McKee, M., 2013. The unequal health of Europeans: successes and failures of policies. Lancet 381 (9872), 1125–1134.

Malaguarnera, M., Vacante, M., Frazzetto, P.M., Motta, M., 2013. What is the frailty in elderly? Value and significance of the multidimensional assessments. Arch. Gerontol. Geriatr. 56 (1), 23–26.

Malmusi, D., 2014. Immigrants' health and health inequality by type of integration policies in European countries. Eur. J. Publ. Health 25 (2), 293–299.

Malter, F. a. a., B.-S., E., 2015. SHARE Wave 5: Innovations & Methodology. MEA, Max Planck Institute for Social Law and Social Policy, Munich.

Massey, D.S., 1990. The social and economic origins of immigration. Ann. Am. Acad. Polit. Soc. Sci. 60–72.

Niessen, J., Huddleston, T., Citron, L., Geddes, A., Jacobs, D., 2007. Migrant Integration Policy Index 2007. Retrieved from: http://www.migpolgroup.com/public/docs/8. MIPEX-2006-2007-final_09.07.pdf.

Peña, F.G., Theou, O., Wallace, L., Brothers, T.D., Gill, T.M., Gahbauer, E.A., et al., 2014. Comparison of alternate scoring of variables on the performance of the frailty index. BMC Geriatr. 14 (1), 1.

Rasbash, J., Steele, F., Browne, W., Goldstein, H., 2013. A User's Guide to MLwiN, v2.28. Centre for Multilevel Modelling. University of Bristol, UK.

Rechel, B., Mladovsky, P., Ingleby, D., Mackenbach, J.P., McKee, M., 2013. Migration and health in an increasingly diverse Europe. Lancet 381 (9873), 1235–1245.

Riosmena, F., Everett, B.G., Rogers, R.G., Dennis, J.A., 2015. Negative acculturation and nothing more? Cumulative disadvantage and mortality during the immigrant adaptation process among Latinos in the United States. Int. Migrat. Rev. 49 (2), 443–478.

Romero-Ortuno, R., Kenny, R.A., 2012. The frailty index in Europeans: association with age and mortality. Age Ageing 41 (5), 684–689.

Salt, J., 2005. Current Trends in International Migration in Europe. Council of Europe.

Santos-Eggimann, B., Cuénoud, P., Spagnoli, J., Junod, J., 2009. Prevalence of frailty in middle-aged and older community-dwelling Europeans living in 10 countries. J. Gerontol. Ser. A. Biol. Med. Sci. 64 (6), 675–681.

Simpson, C.F., Boyd, C.M., Carlson, M.C., Griswold, M.E., Guralnik, J.M., Fried, L.P., 2004. Agreement between self-report of disease diagnoses and medical record validation in disabled older women: factors that modify agreement. J. Am. Geriatr. Soc. 52 (1), 123–127.

Solé-Auró, A., Crimmins, E.M., 2008. Health of immigrants in European Countries. Int. Migrat. Rev. 42 (4), 861–876.

Theou, O., Brothers, T.D., Rockwood, M.R., Haardt, D., Mitnitski, A., Rockwood, K., 2013. Exploring the relationship between national economic indicators and relative fitness and frailty in middle-aged and older Europeans. Age Ageing aft010.

United Nations Department of Economic and Social Affairs, 2013. Trends in International Migrant Stock: the 2013 revision (United Nations database, POP/DB/MIG/stock/Rev.2013). Retrieved from: http://esa.un.org/unmigration/TIMSA2013/Data/subsheets/UN_MigrantStock_2013T3.xls.

United Nations Statistics Division, 2015. Composition of Macro Geographical (continental) Regions, Geographical Sub-regions, and Selected Economic and Other Groupings.

Wakabayashi, C., 2010. Effects of immigration and age on health of older people in the United States. J. Appl. Gerontol. 29 (6), 697–719.

Weitoft, G.R., Gullberg, A., Hjern, A., Rosén, M., 1999. Mortality statistics in immigrant research: method for adjusting underestimation of mortality. Int. J. Epidemiol. 28 (4), 756–763.

Williams, R., 1993. Health and length of residence among South Asians in Glasgow: a study controlling for age. J. Publ. Health 15 (1), 52–60.

World Bank, 2014. World Bank analytical classifications. Retrieved from: http://siteresources.worldbank.org/DATASTATISTICS/Resources/OGHIST.xls.