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The Frailty Instrument of the Survey of Health, Ageing and Retirement in Europe (SHARE-FI) predicts mortality beyond age, comorbidities, disability, self-rated health, education and depression

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Keywords

Frail Elderly; Severity of Illness Index; Longitudinal Study; Mortality; Sex Differences; Europe

Introduction

Frailty in older adults is a key clinical concept characterised by dysregulation of multiple biological systems, accumulation of deficits, vulnerability to stressors and increased risk of adverse outcomes such as falls, disability, hospitalisation, institutionalisation and death (1–3). Although there is no international consensus on the definition of frailty (4), one of the most accepted operationalisations is that of Fried *et al.*, who defined it as a clinical syndrome in which three or more of the following are present: unintentional weight loss, exhaustion, weakness, slow walking speed, and low physical activity (5).

Frailty is an emerging concept in General Practice and has the potential to provide commissioners of health care with a clinical focus for targeting resources at an ageing population (6, 7). However, operationalising Fried's frailty phenotype on an individual patient requires complex calculations on a reference sample, which is not practical in the context of primary care. Indeed, family physicians and community practitioners are in need of easy instruments for frailty (8).

To provide European community practitioners with an easy frailty metric, we created and validated a Frailty Instrument for primary care (SHARE-FI) based on the *Survey of Health, Ageing and Retirement in Europe* (9). The SHARE-FI calculators (one for each gender) are freely accessible on *BMC Geriatrics* (<http://www.biomedcentral.com/1471-2318/10/57>) and their use is intended for community-dwelling adults aged 50 and over. In our main study, we demonstrated that SHARE-FI was a powerful predictor of mortality over a mean follow-up of 2.4 years, even after adjusting for baseline age (9).

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Conflicts of interest

None.

Ageing, comorbidity, disability and frailty are distinct (albeit causally related) clinical entities (10–14). Our main study (9) did not report how SHARE-FI predicts mortality after adjusting for those and other potential confounders such as self-rated health (15, 16), education level (17, 18) and depression (19). The present study investigates the robustness SHARE-FI to predict mortality in the face of those important covariates.

Methods

Subjects

17,304 females and 13,811 males included in the first wave of the Survey of Health, Aging and Retirement in Europe (SHARE, release 2.3.0 of November 13th, 2009), corresponding to nationally representative samples of 12 European countries (Austria, Germany, Sweden, Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Belgium and Israel).

Creation of SHARE-FI

As detailed in our main study (9), SHARE-FI was created via estimation of a discrete factor (DFactor) model based on five SHARE frailty items (Figure 1), using LatentGOLD® (version 4.5.0). The five frailty items were proposed by Santos-Eggimann *et al.* (20). A single DFactor with three ordered levels or latent classes (*non-frail*, *pre-frail* and *frail*) was obtained for each gender. Figure 2 summarises the original development and validation of SHARE-FI (9).

Mortality prediction

Wave 2 established whether wave 1 participants had died, were still alive, or had been lost to follow-up. For those who had died, the exact time to death since the initial interview was not collected. Wave 1 data were collected between 2004–2006 and wave 2 between 2006–2007. The mean individual follow up period between Wave 1 and Wave 2 was 2.4 years.

Covariates

- *Age* (years).
- *Number of years of education*. Based on respondents' self-report of their highest level of education achieved, years of education were derived from the 1997 International Standard Classification of Education (ISCED-97) (21).
- *Self-rated health* on the following scale: 1: excellent; 2: very good; 3: good; 4: fair; or 5: poor.
- *Number of chronic diseases* (active or in the past) diagnosed by a doctor, from the following list:
 - a) Heart attack or myocardial infarction or coronary thrombosis or any other heart problem including congestive heart failure; b) High blood pressure or hypertension; c) High blood cholesterol; d) Stroke or cerebral vascular disease; e) Diabetes or high blood sugar; f) Chronic lung disease such as chronic bronchitis or emphysema; g) Asthma; h) Arthritis, including osteoarthritis, or rheumatism; i) Osteoporosis; j) Cancer or malignant tumour, including leukaemia or lymphoma, but excluding minor skin cancers; k) Stomach or duodenal ulcer, peptic ulcer; l) Parkinson disease; m) Cataracts; n) Hip fracture or femoral fracture; o) Other fractures; p) Alzheimer's disease, dementia or senility; q) Benign tumour, and r) Other conditions.
- *Number of limitations with activities of daily living* (ADL), from the following list (one point per each limitation):

a) Dressing, including putting on shoes and socks; b) Walking across a room; c) Bathing or showering; d) Eating, such as cutting up the food; e) Getting in and out of bed, and f) Using the toilet, including getting up or down.

- *EURO-D* depression scale (22).

Statistical analyses

Binary logistic regressions were conducted with SPSS 16.0 to assess whether the frailty classes at Wave 1 significantly predicted whether or not a subject was dead by Wave 2. In the models, the frailty class variable was entered as a categorical predictor, using the non-frail class as reference category, and simple contrasts were requested. The dependent variable (i.e. dead at Wave 2, coded 0 = no and 1 = yes) included non-missing data only. The odds ratio (OR) for mortality was indicated by the Exp(B) statistic in the binary logistic regression model. Ninety-five percent confidence intervals for ORs were requested.

Four logistic regression models were computed: unadjusted (model 1) and age-adjusted (model 2), as previously reported (9); model 3 was adjusted by age, number of chronic diseases and number of ADL limitations; and model 4 was adjusted by age, number of chronic diseases, number of ADL limitations, self-rated health, years of education, and EURO-D score.

The logistic regression assumption of independent variables being linearly related to the logit was checked, and the fit of the models was checked with the Hosmer and Lemeshow test. Given the large sample size and consistent with our main publication (9), the level of significance was set at 0.01.

Results

The mean age (standard deviation) of females was 63.6 (11.1), and that of males was 64.1 (9.9). Complete data for assessing frailty according to the approach by Santos-Eggimann *et al.* (20) were available for 15,578 females and 12,783 males.

Of the females with data available ($N = 15,578$), 66.9% were non-frail ($N = 10,420$), 25.8% were pre-frail ($N = 4,025$) and 7.3% were frail ($N = 1,133$). Of the males ($N = 12,783$), 82.3% were non-frail ($N = 10,517$), 14.6% were pre-frail ($N = 1,871$) and 3.1% were frail ($N = 395$).

By wave 2, information on the vital status was available for 11,384 females and 9,163 males. The crude mortality rate in females was 0.7% (non-frail), 2.6% (pre-frail) and 9.2% (frail). In males, the mortality was 2.0% (non-frail), 8.8% (pre-frail) and 22.6% (frail). The mortality effect was clearly incremental across frailty categories (9).

Table 1 shows the results of the binary logistic regression models. In model 4 (females), significant predictors were *age* (OR: 1.1, $P < 0.001$) and *frail* class (OR: 2.9, 95% CI: 1.3 – 6.2, $P = 0.006$). In males, significant predictors were *age* (OR: 1.1, $P < 0.001$), self-rated health (OR: 2.0, 95% CI: 1.5 – 2.5, $P < 0.001$) and *frail* class (OR: 2.5, 95% CI: 1.3 – 4.9, $P = 0.007$). Both models met the assumption of independent variables being linearly related to the logit and had a favourable Hosmer and Lemeshow test: $\chi^2 = 7.671$, $df = 8$, $P = 0.466$ (females) and $\chi^2 = 6.329$, $df = 8$, $P = 0.610$ (males).

Conclusion

This study showed that SHARE-FI is a robust predictor of mortality even after adjusting for age, comorbidity, disability, self-rated health, education and depression. The OR for the frail

class was more than twice as high as that of age alone, with age *per se* having a modest (OR: 1.1) effect. Indeed, frailty is more related to the *biological* than to the *chronological* age of individuals (12,14).

In model 4, the *pre-frail* class disappeared as a significant predictor of mortality ($P \geq 0.01$ in both genders). Interestingly, the *pre-frail* state has been referred to in the literature as a state of less 'inevitability' that may be more amenable to interventions than the frail state (23–25). Therefore, it is important that frailty interventions focus on minimising *transitions* from the pre-frail (which may be more benign from a mortality point of view) to the frail state (which has clear mortality implications), and maximise transitions from the frail to the pre-frail (or even non-frail) states.

The finding of a significant effect of self-reported health in males (but not in females) is in keeping with previous research that there may be gender differences in the association between self-rated health and mortality (15).

A limitation of this study is the significant proportion of missing mortality data, which was available for only 66% of the baseline sample. However, in our main study we conducted a sensitivity analysis suggesting that there was a higher burden of frailty at baseline in those for whom mortality information could not be obtained at follow-up, which could have resulted in *underestimation* of the age-adjusted mortality odds ratios (9).

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References

1. Gobbens RJ, Luijckx KG, Wijnen-Sponselee MT, Schols JM. In search of an integral conceptual definition of frailty: opinions of experts. *J Am Med Dir Assoc*. 2010 Jun; 11(5):338–343. [PubMed: 20511101]
2. Xue QL. The frailty syndrome: definition and natural history. *Clin Geriatr Med*. 2011 Feb; 27(1):1–15. [PubMed: 21093718]
3. Campbell AJ, Buchner DM. Unstable disability and the fluctuations of frailty. *Age Ageing*. 1997 Jul; 26(4):315–318. [PubMed: 9271296]
4. Conroy S. Defining frailty--the Holy Grail of geriatric medicine. *J Nutr Health Aging*. 2009 Apr. 13(4):389. [PubMed: 19300887]
5. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci*. 2001 Mar; 56(3):M146–M156. [PubMed: 11253156]
6. Drey M, Wehr H, Wehr G, Uter W, Lang F, Rupprecht R, et al. The frailty syndrome in general practitioner care: a pilot study. *Z Gerontol Geriatr*. 2010 Feb; 44(1):48–54. [PubMed: 20809282]
7. De Lepeleire J, Illiffe S, Mann E, Degryse JM. Frailty: an emerging concept for general practice. *Br J Gen Pract*. 2009 May; 59(562):e177–e182. [PubMed: 19401013]
8. De Lepeleire J, Degryse J, Illiffe S, Mann E, Buntinx F. Family physicians need easy instruments for frailty. *Age Ageing*. 2008 Jul. 37(4):484. author reply -5. [PubMed: 18515292]
9. Romero-Ortuno R, Walsh CD, Lawlor BA, Kenny RA. A Frailty Instrument for primary care: findings from the Survey of Health, Ageing and Retirement in Europe (SHARE). *BMC Geriatr*. 2010; 10:57. [PubMed: 20731877]

10. Polidoro A, Dornbusch T, Vestri A, Di Bona S, Alessandri C. Frailty and disability in the elderly: A diagnostic dilemma. *Arch Gerontol Geriatr.* 2010 Mar–Apr; 52(2):e75–e78. [PubMed: 20615558]
11. Wahlin A, MacDonald SW, deFrias CM, Nilsson LG, Dixon RA. How do health and biological age influence chronological age and sex differences in cognitive aging: moderating, mediating, or both? *Psychol Aging.* 2006 Jun; 21(2):318–332. [PubMed: 16768578]
12. Schuurmans H, Steverink N, Lindenberg S, Frieswijk N, Slaets JP. Old or frail: what tells us more? *J Gerontol A Biol Sci Med Sci.* 2004 Sep; 59(9):M962–M965. [PubMed: 15472162]
13. Fried LP, Ferrucci L, Darer J, Williamson JD, Anderson G. Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care. *J Gerontol A Biol Sci Med Sci.* 2004 Mar; 59(3):255–263. [PubMed: 15031310]
14. Mitnitski AB, Graham JE, Mogilner AJ, Rockwood K. Frailty, fitness and late-life mortality in relation to chronological and biological age. *BMC Geriatr.* 2002 Feb 27;2:1. [PubMed: 11897015]
15. Lyyra TM, Leskinen E, Jylha M, Heikkinen E. Self-rated health and mortality in older men and women: a time-dependent covariate analysis. *Arch Gerontol Geriatr.* 2009 Jan–Feb; 48(1):14–18. [PubMed: 17950481]
16. Cesari M, Onder G, Zamboni V, Manini T, Shorr RI, Russo A, et al. Physical function and self-rated health status as predictors of mortality: results from longitudinal analysis in the iLSIRENTE study. *BMC Geriatr.* 2008; 8:34. [PubMed: 19102751]
17. Liu X, Hermalin AI, Chuang YL. The effect of education on mortality among older Taiwanese and its pathways. *J Gerontol B Psychol Sci Soc Sci.* 1998 Mar; 53(2):S71–S82. [PubMed: 9520932]
18. Sundquist J, Johansson SE. Self reported poor health and low educational level predictors for mortality: a population based follow up study of 39,156 people in Sweden. *J Epidemiol Community Health.* 1997 Feb; 51(1):35–40. [PubMed: 9135786]
19. Hamer M, Bates CJ, Mishra GD. Depression, physical function, and risk of mortality: National Diet and Nutrition Survey in adults older than 65 years. *Am J Geriatr Psychiatry.* 2010 Jan; 19(1):72–78. [PubMed: 20808095]
20. Santos-Eggimann B, Cuenoud P, Spagnoli J, Junod J. Prevalence of frailty in middle-aged and older community-dwelling Europeans living in 10 countries. *J Gerontol A Biol Sci Med Sci.* 2009 Jun; 64(6):675–681. [PubMed: 19276189]
21. OECD. Classifying Educational Programmes: Manual for ISCED-97 Implementation in OECD Countries (1999 edition). Available online: <http://www.oecd.org/dataoecd/7/2/1962350.pdf>
22. Prince MJ, Reischies F, Beekman AT, Fuhrer R, Jonker C, Kivela SL, et al. Development of the EURO-D scale--a European, Union initiative to compare symptoms of depression in 14 European centres. *Br J Psychiatry.* 1999 Apr; 174:330–338. [PubMed: 10533552]
23. Dahlin-Ivanoff S, Gosman-Hedstrom G, Edberg AK, Wilhelmson K, Eklund K, Duner A, et al. Elderly persons in the risk zone. Design of a multidimensional, health-promoting, randomised three-armed controlled trial for "prefrail" people of 80+ years living at home. *BMC Geriatr.* 2010; 10:27. [PubMed: 20504358]
24. Faber MJ, Bosscher RJ, Chin APMJ, van Wieringen PC. Effects of exercise programs on falls and mobility in frail and pre-frail older adults: A multicenter randomized controlled trial. *Arch Phys Med Rehabil.* 2006 Jul; 87(7):885–896. [PubMed: 16813773]
25. Gill TM, Gahbauer EA, Allore HG, Han L. Transitions between frailty states among community-living older persons. *Arch Intern Med.* 2006 Feb 27; 166(4):418–423. [PubMed: 16505261]

SHARE-FI**EXHAUSTION**

In the last month, have you had too little energy to do the things you wanted to do?

- No
- Yes

LOSS OF APPETITE

What has your appetite been like?

- Diminution in desire for food and/or eating less than usual
- No change in desire for food and/or eating the same as usual
- Increase in desire for food and/or eating more than usual

WEAKNESS

Maximum grip strength in Kilograms:

- Right hand attempt 1
- Right hand attempt 2
- Left hand attempt 1
- Left hand attempt 2

WALKING DIFFICULTIES

Because of a health or physical problem, do you have any difficulty doing any of the following everyday activities? (Exclude any difficulties that you expect to last less than three months)

Walking 100 metres:

- Yes
- No

Climbing one flight of stairs without resting:

- Yes
- No

LOW PHYSICAL ACTIVITY

How often do you engage in activities that require a low or moderate level of energy such as gardening, cleaning the car, or doing a walk?

- More than once a week
- Once a week
- One to three times a month
- Hardly ever, or never

Figure 1.

SHARE-FI items. The online calculators can be found at <http://www.biomedcentral.com/1471-2318/10/57/additional/> and <https://sites.google.com/a/tcd.ie/share-frailty-instrument-calculators/> (translated versions).

SHARE FRAILTY INSTRUMENT

Figure 2.

Development and validation of SHARE-FI (separately for each gender). The illustration has been reproduced with permission of the authors (copyright holders) from the original SHARE-FI study (<http://www.biomedcentral.com/1471-2318/10/57>). The latter is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/2.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Table 1

SHARE-FI categories: results of the logistic regression models for the prediction of mortality.

Women (N = 11,384)			Men (N = 9,163)						
B	SE	P	OR	CI (95%)	B	SE	P	OR	CI (95%)
Model 1: unadjusted									
Non-frail	-	-	<0.001	1.0	-	-	<0.001	1.0	-
Pre-frail	1.30	0.19	<0.001	3.7	2.5 – 5.3	1.57	0.13	<0.001	4.8
Frail	2.66	0.19	<0.001	14.2	9.7 – 20.8	2.68	0.18	<0.001	14.6
Model 2: adjusted by age									
Age	0.09	0.01	<0.001	1.1	1.1 – 1.1	0.07	0.01	<0.001	1.1
Non-frail	-	-	<0.001	1.0	-	-	-	<0.001	1.0
Pre-frail	0.72	0.20	<0.001	2.1	1.4 – 3.0	1.11	0.14	<0.001	3.0
Frail	1.57	0.22	<0.001	4.8	3.1 – 7.4	1.93	0.19	<0.001	6.9
Model 3: adjusted by age, number of chronic diseases and number of limitations with ADLs									
Age	0.08	0.01	<0.001	1.1	1.1 – 1.1	0.07	0.01	<0.001	1.1
Number of chronic diseases	0.08	0.05	0.097	1.1	1.0 – 1.2	0.10	0.04	0.019	1.1
Number of limitations with ADLs	0.12	0.07	0.111	1.1	1.0 – 1.3	0.12	0.07	0.106	1.1
Non-frail	-	-	<0.001	1.0	-	-	-	<0.001	1.0
Pre-frail	0.63	0.20	0.002	1.9	1.3 – 2.8	1.01	0.15	<0.001	2.8
Frail	1.34	0.24	<0.001	3.8	2.4 – 6.1	1.66	0.22	<0.001	5.3
Model 4: adjusted by age, number of chronic diseases, number of limitations with ADLs, self-rated health, education, EURO-D score									
Age	0.09	0.01	<0.001	1.1	1.1 – 1.1	0.08	0.01	<0.001	1.1
Number of chronic diseases	0.04	0.07	0.533	1.0	0.9 – 1.2	−0.08	0.07	0.250	0.9
Number of limitations with ADLs	0.00	0.11	0.990	1.0	0.8 – 1.3	0.10	0.11	0.333	1.1
Self-rated health	0.20	0.14	0.149	1.2	0.9 – 1.6	0.67	0.12	<0.001	2.0
Number of years of education	0.01	0.03	0.714	1.0	1.0 – 1.1	0.01	0.02	0.796	1.0
EURO-D	0.02	0.05	0.754	1.0	0.9 – 1.1	0.05	0.04	0.246	1.1
Non-frail	-	-	0.022	1.0	-	-	-	0.018	1.0
Pre-frail	0.41	0.29	0.158	1.5	0.9 – 2.7	0.50	0.23	0.033	1.6
									1.0 – 2.6

	Women (N = 11,384)					Men (N = 9,163)				
	B	SE	P	OR	CI (95%)	B	SE	P	OR	CI (95%)
Frail	1.06	0.39	0.006	2.9	1.3 – 6.2	0.92	0.34	0.007	2.5	1.3 – 4.9

B: unstandardised regression coefficient; SE: standard error; OR: Odds Ratio; CI: confidence interval; ADL: activities of daily living; EURO-D: EURO-D scale of depressive symptoms (21).