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Prevalence of frailty phenotypes and risk of mortality in a community-dwelling elderly cohort

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Abstract

Objectives: to determine the prevalence of three independent, disability-free and operationally defined frailty phenotypes and the associated risk of mortality in a community-dwelling older people cohort over 74 years of age.
Methods: observational, prospective and population-based design. Bio-psycho-social variables were assessed using a range of standardised instruments. The physical frailty phenotype (PFP), mental frailty phenotype (MFP) and social frailty phenotype (SFP) were operationally defined using a deficit accumulation model that excluded disability. Logistic regression analyses explored associations of the frailty phenotypes with sex, age and marital status, and a Cox proportional hazard regression analysis was performed to evaluate the association between frailty phenotypes and mortality.
Results: of the eligible individuals, 82% ($n = 875$) participated. The prevalence of any frailty phenotype in an individual was 38.8%; 17.3% exhibited the PFP, 20.2% exhibited the MFP, and 8.9% exhibited the SPF. Older and female were more likely to exhibit the PFP, and widowhood was associated with the SFP. The hazard ratios of mortality were 3.09 (95% CI = 1.54–6.17) for the PFP and 2.69 (95% CI = 1.01–7.25) for the SFP.
Conclusion: three different disability-free frailty phenotypes were differentially related to the socio-demographical characteristics of sex, age and marital status and independently predicted risk of mortality.

Keywords: *frailty, prevalence, cohort studies, epidemiology, mortality, elderly*

Introduction

Although there is no consensus regarding the definition of frailty, experts agree that it reflects the vulnerability to adverse health outcomes [1–3]. Because frailty is influenced by age and exhibits an exponential increase in prevalence across the adult lifespan [4], it has become a prominent topic in geriatric studies.

While much effort has been devoted to establishing a standardised measure of frailty [2, 5, 6], there is no agreement on the best assessment instrument. The two primary assessment measures are the physical frailty phenotype (PFP) [7], which relies solely on physical variables, and the multidomain phenotype of frailty, which assumes that frailty is due to an accumulation of deficits in multiple areas such as disease, physical and cognitive impairment, and psychosocial risk factors [8]. Both of these widely used measures have been modified in regard to the number of items/variables assessed and/or in the measurement method [4, 9–14]. The inclusion of disability among the factors used to assess frailty is controversial. While many authors have used disability as an indicator of frailty [2, 15], in 2008, a panel of specialists defined frailty as a predisability stage and recommended that it should not be used to assess frailty because disability was a consequence of frailty [2].

To date, most of the available assessment methods permit subcategories that reflect the degree of frailty, such as prefrail, frail and non-frail, which are useful when rating the risk of adverse clinical outcomes. However, none of these methods distinguishes among the subtypes of frailty

based on differences in the dimensions included in the frailty phenotype. If each frailty dimension has different predictors and different impacts on mortality, it is important to evaluate the prevalence and predictors of these phenotypes separately.

This study was designed to determine the prevalence of frailty and the associated risk of mortality after 4 years in a community-dwelling elderly cohort over the age of 74. In this study, frailty was defined as a multifactorial state in persons without disability; this definition considered not only the cumulative effect of the factors, but also the qualitative nature (physical, mental or social) of the factors included in the frailty index. This allowed the operational definition of three separate phenotypes of frailty—a PFP, a mental frailty phenotype (MFP) and a social frailty phenotype (SFP).

Methods

Study setting population and design

This population-based study recruited a representative sample of inhabitants over the age of 74 from 8 rural villages in the Anglès Primary Health Care Area in Girona, NE Spain. The sample size was calculated based on the estimated prevalence of frailty and assumed a prevalence of 20% in community-dwelling individuals aged 75–84 years and 40% in those older than 84 years, with an alpha level of 0.05 for a precision of ±0.02. The inclusion criterion was primary residence in the participating municipalities, and exclusion criteria were residence in a long-term care facility or the inability to contact the prospective participant after five attempts. The Institutional Review Board of the Institut d'Assistència Sanitària approved the research protocol and written informed consent was obtained from each study participant.

Data collection and study variables

Participants were interviewed in their homes. Demographic information on participant age, sex, marital status and education was collected.

The World Health Organization Disability Assessment Schedule II (WHODAS-II) scale 12-item interviewer-administered version [16] assessed the individual's level of functional independence. Participants scoring 6 points or less were regarded as functionally independent, participants scoring 7–12 points were regarded as displaying some level of disability and participants scoring 13 points or more were regarded as functionally dependent in one or more activities of daily living.

Comorbidity was determined based on the number of self-reported chronic diseases. Balance was evaluated using the one-leg stand test [17]. Nutritional state was assessed with the Mini-Nutritional Assessment [18]. Hearing impairment was assessed with the whispered voice test [19]. Participants' visual acuity was assessed using a Snellen chart placed 6 m from the individual. Standardised questions obtained information regarding bladder and/or bowel incontinence. The medications prescribed for participants were classified based on the anatomical therapeutic chemical classification [20]. Suspected cognitive impairment was evaluated with the Mini-Mental State Examination [21]. Depressive symptomatology was assessed with the 5-item version of the Geriatric Depression Scale [22]. The Subjective Aging Perception Scale assessed the individual's cognitive self-concept [23]. The individual's quality of life was measured using a visual analogue scale that ranged from 0 to 100 points. Participants also responded to standardised questions regarding how often he/she was in contact with family, friends and neighbours, whether another person was available to help with ADL if necessary, and the availability of a confidant.

The participant was the primary source of information; however, relatives or caregivers provided information for individuals with severe hearing impairment, comprehension difficulties or whenever low-reliability information was suspected. Data were collected from 1 November 2006 to 31 May 2007. Four years later, the vital status of all study participants was checked using the information from the individual electronic medical charts of the Anglès Primary Health Care Area.

Operational definitions of the frailty phenotypes

Adopting the hypothesis that the accumulation of deficits increases frailty, the goal was to establish operational definitions of frailty based on deficit accumulation in the absence of disability. Operational definitions of frailty consisted of indicators that were rated as present or absent. For details of operational criteria, please see the table Appendix 1 in the Supplementary data available in *Age* and *Ageing* online.

Statistical analyses

Participants who scored higher than 6 points on the WHODAS-II were not included in the analyses. The prevalence of each frailty phenotype and the co-occurrence of frailty phenotypes within individuals were assessed. Binary logistic regression analyses were performed to determine the association of sex and age with the prevalence of each frailty phenotype. A Cox proportional hazards regression analysis at the subject level was performed to compute the multivariate-adjusted mortality risk. The assumption of proportional hazards was tested using log-minus-log survival plots. Survival intervals were calculated from the date of enrolment to the date of death, and survival intervals were censored for those participants who were still alive in the date when their vital status was determined. The model included the variables of age, sex, civil status, and the physical, mental and SFPs. Results were expressed as absolute numbers and percentages, means, standard deviations, odds ratios and 95% confidence intervals (95% CI). Statistical tests were considered to be significant for a two-tailed P-value <0.05.

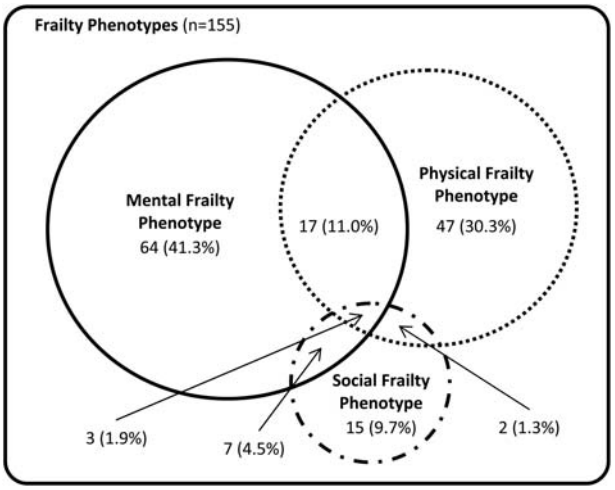

Figure 1. Prevalence and co-occurrence of the three frailty phenotypes.

Results

Of the 1,245 selected participants, 180 did not meet the inclusion criteria and 190 declined to participate in the study. Of the eligible candidates, 82% ($n = 875$) participated in the study (please see the figure in Appendix 1 in the Supplementary data available in *Age* and *Ageing* online). The mean age was 81.7 years (SD = 4.8), and 58.2% were women ($n = 509$). Study participants and non-participants did not differ significantly in sex or age; the mean age of non-participants was 81.4 (Mann–Whitney U = 591.0, $P = 0.427$), and 60.3% were women ($\chi^2 = 0.16$, df = 1, $P = 0.681$).

Based on WHODAS-II scores, 36.6% of the participants were functionally dependent (95% CI = 33.3–39.8; $n = 320$), 17.7% exhibited some level of disability (95% CI = 15.1–20.3; $n = 155$) and 45.7% were functionally independent (95% CI = 42.4–49.1; $n = 400$). There was a progressively greater severity of most of the frailty indicators for the dependent and disabled patients compared with those who were functionally independent (please see the table in Appendix 2 in the Supplementary data available in *Age* and *Ageing* online).

The prevalence of any frailty phenotype was 38.8% (95% CI = 33.9–43.6; $n = 155$). The prevalence of the PFP was 17.3% (95% CI = 13.4–21.1; $n = 69$), and there were significant differences based on sex and age. The prevalence of the MFP was 22.8% (95% CI = 18.1–27.0; $n = 91$) and it was not associated to sex or age. The prevalence of the SFP was 6.8% (95% CI = 4.2–9.3; $n = 27$) and was associated with sex. Please see the figure in Appendix 2 in the Supplementary data available in *Age* and *Ageing* online for the prevalence of each frailty phenotype by sex and age group.

The analysis of the overlap between the frailty phenotypes revealed that having MFP only was the most frequent phenotype (95% CI = 33.2–49.3), followed by having PFP only (95% CI = 22.8–37.9) and by the co-occurrence of PFP and MFP (95% CI = 5.7–16.2) (Figure 1).

Table 1. Odds ratios and 95% confidence intervals for prevalence of the three frailty phenotypes by sex and age

	Physical frailty phenotype	Mental frailty phenotype	Social frailty phenotype
Sex			
Male	1	1	1
Female	2.17 (1.15–4.08)*	0.99 (0.58–1.70)	2.75 (0.95–8.00)
Age			
75–79 years	1	1	1
80–84 years	2.76 (1.54–5.26)*	1.36 (0.79–2.34)	0.69 (0.27–1.75)
≥85 years	4.23 (1.90–9.41)*	1.18 (0.55–2.53)	0.76 (0.20–2.88)
Marital status			
Married	1	1	1
Single	1.14 (0.38–3.43)	1.34 (0.49–3.64)	3.79 (0.87–16.39)
Widowed	0.92 (0.48–1.76)	1.19 (0.66–2.12)	3.61 (1.33–9.76)*

*$P < 0.05$.

Table 1 presents the results of the logistic regression models measuring the association of age and sex with the different frailty phenotypes. The PFP risk was higher for women and increased with age. Only widowers were at higher risk of exhibiting SFP, but neither sex nor age was associated with the MFP.

The mean follow-up time for the sample of functionally independent participants was 3.6 years (SD = 1.1), and 52 (13.5%) of the individuals died during this period. Table 2 presents the results of the Cox proportional hazards regression analysis. The most important mortality hazard ratios were the PFP and the SFP. The MFP did not reach statistical significance, and female sex was a protective factor. When combining frailty phenotypes the mortality hazard ratio for those who meet criteria for one phenotype was 1.9 (95% CI = 1.1–3.7), for those with two phenotypes was 3.9 (95% CI = 1.5–9.8) and for those with three phenotypes was 10.4. (95% CI = 2.7–41.6). Please see the figure in

Table 2. Mortality hazard ratios (HR) and confidence intervals (95% CI)

	HR	95% CI
Sex		
Male	1	—
Female*	0.35	0.17–0.71
Age*	1.08	1.01–1.16
Marital status		
Widowed	1	—
Married	0.62	0.31–1.23
Single	0.45	0.10–2.02
Physical frailty phenotype*	3.09	1.54–6.17
Mental frailty phenotype	1.23	0.64–2.36
Social frailty phenotype*	2.69	1.01–7.25

*$P < 0.05$.

Appendix 3 in the Supplementary data available in *Age* and *Ageing* online for survival curves.

Discussion

The study findings were consistent with previous studies of frailty prevalence and with the association of frailty to mortality. Frailty was associated with sociodemographical factors, and frailty increased the risk of mortality. Nonetheless, the study findings exhibited two major differences with the existing literature. First, Rockwood's [24] model of frailty was adopted, and frailty was defined in terms of accumulated functional deficits. However, disability was excluded following the recommendations of an International Geriatric Advisory Panel [2] that disability should not be included in frailty definitions and assessment tools because it was an outcome of frailty. Second, PFP, MFP and SFP were distinguished based on the qualitative nature of the indicators used to identify frailty. The distinction between the frailty phenotypes reflected the hypothesis that the inclusion of qualitatively different frailty indicators in a multidimensional index, although possibly highly predictive of death or institutionalisation, would obscure the differential effects of distinct configurations of frailty indicators.

To date, the reported prevalence rates of frailty in the general population have been inconsistent due to differences in the conceptualisation and measurement of frailty. The prevalence of the PFP in the present study was 17.3%. Santos-Eggimann *et al.* [25] reported a prevalence of 17% for a large sample of community-dwelling Europeans over the age of 64 in a study that employed the PFP defined by Fried *et al.* [7]. A study of a representative sample of community-dwelling Canadians over the age of 64 that used the multidomain frailty index years found that the prevalence was 22.7% [26]. The prevalence of any frailty phenotype in the current study was 38.8%. In other community-based studies that used different definitions of frailty, the prevalence of frailty has ranged from 7 to 48% [13, 26] (please see the reference list in Appendix 1 in the Supplementary data available in *Age* and *Ageing* online for a recent literature review on frailty).

In addition to revealing different prevalence rates for each frailty phenotype, the present study also made it possible to examine the overlap between phenotypes. It is worth noting that the MFP was the most frequent, followed by the PFP, and that the combination of these two phenotypes was the most frequent type of overlap. This result provides support for a multidomain approach to frailty and reveals the need to include measures of cognitive function in the definition of frailty [27]. With regard to this issue, an analysis of the relation between cognitive function and physical performance suggested that global cognitive function exhibits decrements more consistently and that these decrements precede or co-occur with a decline in physical performance in older women [28]. Almost half of the individuals exhibiting the SFP also exhibited either the mental or physical phenotypes (or both), but the remaining individuals surprisingly exhibited this phenotype in isolation. This result supports previous research on the relation of social vulnerability to frailty and reveals that although the study variables are related they are nonetheless distinct. Andrew *et al.* developed a social vulnerability index that was associated with reduced medium-term survival and was moderately correlated with a multidomain-based frailty index [29]. Moreover, results from the English Longitudinal Study on Ageing found that the presence of frailty increased as individual and neighbourhood socioeconomic factors decreased, suggesting that social isolation or vulnerability was a marker for frailty [29]. The SFP may be considered as a vulnerability indicator characterised by social disadvantage in persons with full functional independence.

Distinguishing the three different phenotypes of frailty made it possible to separately analyse the effects of sociodemographical factors such as gender, age and marital status. The greater prevalence of frailty in women has been repeatedly documented [7, 27], and the multivariate model in the present study confirmed that women were more prone to exhibit the PFP than men. Unexpectedly, the MFP was not influenced by sex but affected men and women equally. Another surprising result was that increasing age was only associated with the PFP. Although the SFP was more frequent in women, the logistic regression analysis suggested that this was due to widowhood.

The use of mortality as an outcome measure provided a relevant adverse outcome for testing the predictive validity of the proposed frailty phenotypes. Although men were not as frail as women, the risk of mortality was greater for men. This finding has been consistently reported regardless of the method used to measure frailty, the level of frailty, the age range or the type of participants included in the study [24]. As expected, the PFP was associated with an increased risk of mortality, and the magnitude of the risk was similar to the risk estimated by a multidomain frailty index [10]. The study results also confirmed the association of social isolation or vulnerability with mortality independently of physical frailty [29, 30].

The strengths of the current study include the use of valid and reliable frailty indicators that were easy to use with a community-based sample, the inclusion of a disability measure to exclude individuals with disability from the frailty phenotypes, and a prospective design that assessed the risk of mortality. However, there were several limitations that must be acknowledged when interpreting the study results. First, although the sample was community based, it was representative of a rural setting so that the findings cannot be extrapolated to urban populations with different lifestyles. Second, it is important to note that some of the frailty indicators were based on self-reports that might have been distorted by recall bias. Third, the relative short follow-up duration might not have been long enough to detect the effect of the MPF on mortality.

In summary, this research was one of the first population-based studies of frailty prevalence and associated mortality risk to exclude disability from the operational definition of frailty and to propose different frailty phenotypes based on the qualitative features of the frailty indicators.

Key points

- This study assessed the prevalence of three qualitatively different frailty phenotypes and the associated risk of mortality.
- The prevalence of frailty phenotypes was associated with sociodemographical characteristics.
- Frailty phenotypes based on deficit accumulation in disability-free individuals increased the risk of mortality.

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Supplementary data

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

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An observational study of psychotropic drug use and initiation in older patients resident in their own home or in care

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Abstract

Objective: to compare the prescription of psychotropic medications for patients living in care homes with that for patients living at home.
Design and setting: retrospective population database study in the Tayside region of Scotland.
Subjects: 70,297 patients aged ≥65 and followed until death or the end of the study.
Methods: examining registered addresses for all people aged 65–99 identified those in care. The prescriptions for a 12-week period was examined and psychotropic drug use compared by their place of residence. Comparisons of prescriptions pre- and post-admission were performed for people admitted to a care home from Jan 2005 to Dec 2006.
Results: people living in care (4.1%) received 9.80 more prescribed items ($P < 0.001$) from 1.63 more British National Formulary (BNF) categories ($P < 0.001$) than people living at home over a 12-week period. They were more likely to receive any psychotropic medication (42 versus 16%, odds ratio (OR) 3.09, 95% CI: 2.79–3.41).
Over 70% of 1,715 people admitted to care homes during the study who received psychotropic medication commenced the medication prior to admission. Patients who started anti-psychotics in the 30 days prior to admission were less likely to have stopped them (OR: 0.53, 95% CI: 0.30–0.94).
Conclusion: prolonged prescription of psychotropic medications is commonplace in care home residents. Almost half of the people prescribed antipsychotic drugs received them for a minimum of 6 months. Systematic medication reviews must be established in all care homes to promote safe and effective prescription to this at-risk population.

Keywords: *psychotropics, care homes, prescribing quality, family practice, patient safety, quality of health care, older people*