

PREDICTOR MODEL OF FRAILITY IN OLD AGE

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Abstract

Background: The Phenotype of Frailty is a syndrome composed of five criteria: weight loss, endurance, physical activity, slowness and weakness. The elder is considered frail if he/she has an impairment in three of these domains. It is known that this condition enhances the risk of disability and death. The objective of this study is to identify predictive and protective factors of frailty. **Methods:** This study includes a representative sample, stratified by age group, of elders living in the community (n=339). We developed a frailty protocol, which integrated the criteria of frailty and bio behavioural, geriatric, functionality, health and mental health self-perception indicators. **Results:** From the analysis of logistic regression models the demographic predictors are: gender (being a woman) (OR 1.7, 95% CI 1.0 - 2.8), age (more advanced) (OR 2.8, 95% CI 1.6 - 4.9) and educational level (no schooling) (OR 2.6, 95% CI 1.1 - 6.0). The bio behavioural variables and the low respiratory flow predict the condition of frailty (OR 3.3, 95% CI 1.9 - 6.0). Geriatric indicators as falls (OR 3.3, 95% CI 1.5 - 5.6), changes in sensory processes, vision and hearing (OR 2.1, 95% CI 1.2 - 3.8; OR 2.1, 95% CI 1.1 - 4.0 respectively) and the presence of at least one comorbidity (OR 1.8, 95% CI 1.0 - 3.2) are predictors of frailty. Impairment in ADL increases the risk of frailty (OR 2.1, 95% IC 1.2 - 3.5). The presence of depressive symptomatology (OR 4.2, 95% IC 1.9-9.2) and cognitive deterioration (OR 2.9, 95% IC 1.6 -5.3) are equally predictive of this condition. On the other hand, maintaining social relations (OR 0.3, 95% IC 0.1-0.5) and a good health self-perception are protective of the condition of frailty (OR 0.4, 95% IC 0.1-0.9). **Conclusions:** Frailty can be predicted through a set of psychosocial and geriatric factors. Protective indicators such as social relations and subjective health act as protective factors of frailty.

Key- words: Ageing, Phenotypic frailty, Predictor factors, Protector indicators.

Background

The normal course of ageing is associated with a gradual decline of functional abilities, in a way that the elders that are at high risk of decline are described as frail (Copari et al., 2006). This is a concept widely used by health professionals to indicate a situation of higher vulnerability that is associated with functional decline. Frailty was an expression rarely mentioned in the literature in the period previous to 1980. Since then, there has been a significant increase of studies regarding the frail elder (Bergman et al., 2007). The concept is based on biomedical sciences (Bucher & Wagner, 1992) and in wider biological models (Campbell & Buchner, 1997). Frailty is described as a cumulative form of unbalances at the metabolic level that make the homeostasis difficult (Hamerman, 1999). Therefore, frailty precedes the appearance of disability (Bucher & Wagner, 1992) and is regarded as a state of higher vulnerability (Abate et al., 2007). However, the physical deficit doesn't necessarily imply the physical condition of frailty but results from the interaction of resources and loss of capacity to environmental challenges (Strawbridge et al., 1998). The literature shows an evolution in the study of the concept of frailty. Up until now the concept has been opened to the inclusion of several domains related to ageing, such as: nutritional, psychological, cognitive and social factors (Levers et al., 2006). What is certain is that this condition must be distinguished from disability (Strandber et al., 2011) and subjects age (Santos-Eggimann et al., 2009). Overall, there are two main approaches that explain frailty in the elderly (Strandber et al., 2011), based on dynamic and interactive means of support (Abellan et al., 2008; Pel – Little et al., 2009) a quantitative approach, developed by the Rockwood team (Rockwood et al., 1994; Rockwood et al., 1999; Rockwood et al., 2004) and a qualitative one, based on the work developed by Fried (Fried et al., 2001; Fried et al., 2004; Bandeen-Roche et al., 2006). The quantitative "index method", particularly promoted by Rockwood, is based not on specific deficits but on a number of cumulative health deficits. The qualitative "phenotypic method" is based on very specific criteria defined by Fried. This scenario increases the emerging attention by professionals working with older people, because it entails different empirical approaches (Markle – Reid et al., 2003).

Phenotype of frailty

The phenotype of frailty has its origins in the Cardiovascular Health Study (CHS) in which it is characterized as a geriatric syndrome with the following criteria: *i)* weight loss: unintentional weight loss in the last year, 5% (or more) of body weight in the previous year; *ii)* weakness: decreased strength (measured with a dynamometer); *iii)* exhaustion: self-reported fatigue, identified by two questions of the Depression Scale of the Centre for Epidemiologic Studies (CES-D); *iv)* slowness: measured by gait speed, indicated in seconds (distance of 4.6 meters), *v)* a low level of activity: result calculated in kilocalories expended per week, measured in terms of self-reported activity and physical exercise. This set of indicators allows classifying a frail elder. The presence of at least three criteria is considered representative of frailty, one to two criteria represents a state of pre or intermediate frailty and the absence of criteria is considered a state of not frailty (robustness). This classification of frailty can predict situations of disability, institutionalization, hospitalization and death (Fried et al., 2001; Fried et al., 2004; Bandeen-Roche et al., 2006).

Methods

The sample

The study was developed in 10 communities, identified by a municipality in northern Portugal. This is a random sample, stratified by age, where there is a representation of each of the age groups. This was built based on the countries Census data (INE, 2002). It was stratified into 3 age groups: 50-59 year-olds (39.5%) 134 subjects, 60-69 year-olds (31.6%) 107 subjects, 70-79 year-olds (19.8%) 67 subjects and 31 subjects over 80 (9.1%) participants.

Instrument and Procedures

A frailty protocol was developed and composed by the following dimensions: sociodemographic; bio behavioural (peak flow and mobility); geriatric (medication, falls, sensorial disorders, sleep and comorbidities), functionality (activities of daily living basic and instrumental); mental status (mood and cognition), quality of life and health self-perception. The field work was done by 10 interviewers with a background on nursing, psychology and social work. Each conducted the interviews at the subjects' home. The hetero-application of the protocol constituted the single evaluation moment, taking about 45 minutes. All these procedures have taken into consideration ethical principles and fundamental human rights ensuring total confidentiality of data and using written informed consent.

Strategy for data analysis

As in other research projects (Woods et al., 2005; Gill et al., 2006; Cawthon et al., 2007; Ávila-Funes et al., 2008; Santos-Eggimann et al., 2009; Rochat et al., 2010) we used a set of indicators adjusted to the original model proposed by Fried (Fried et al., 2001): weight loss: "Did you intentionally lose weight in last 6 months?"; resistance (exhaustion): item from the Geriatric Depression Scale (GDS) "Do you feel full of energy?" (Yesavage, 1986); physical activity: Scale of Time Use "Do you usually practise sports activities (swimming, cycling, walking, gymnastics, or fitness)?" (Duarte & Martín, 2008); slowness (walking time): Time Up and Go

(<10 sec = independent; ≥ 10 sec = some dependency) (Podsiadlo & Richardson, 1991); weakness (assessment of hand strength): stratified by gender (Men ≥ 31 kilocalories 18kg Women ≥ 18 kilocalories Kerr et al., 2006).

Statistical Analysis

In a first stage, we used the descriptive analysis of the phenotype of frailty followed by the inferential study, using logistic regression models. For their application we considered the endogenous variable frailty (3 or more frailty criteria) and as exogenous variables (independent) the groups of variables: sociodemographic, bio behavioural determinants, geriatric indicators, functionality, mental health, quality of life and health self-perception controlled by gender and age. The statistical support used was SPSS-Statistical Package for Social Sciences, version 20.0.

Results

According to the analyses of Table 1 we can see that this sample is composed by more women (53,4%) , married (82.0%), and without education level (88,8%).

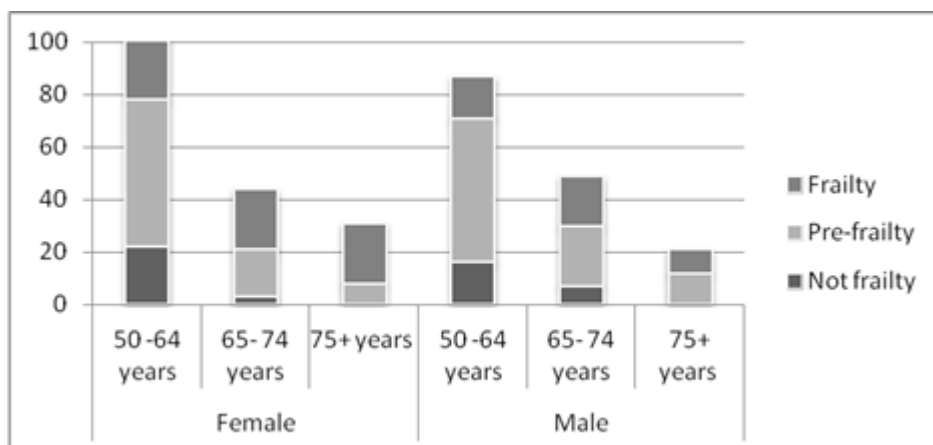
Table 1 – Sociodemographic characterization of sample

	N	%
Gender		
Male	158	46,6
Female	181	53,4
Age(average/standard deviation)	64,4 (9,25)	
Marital Status		
Single	17	4,7
Married	277	82,0
Widow/widower/ Separated/Divorced	45	13,3
Education		
Not attend	38	11,2
Attended	301	88,8

Prevalence of the frailty phenotype

As for the study of phenotypic frailty, we can see that 48 elders (14.2%) didn't score in any of the five criteria of frailty; 172 (50.9%) scored in 1 to 2 criteria of frailty and 118 (34.9%) had 3 to 5 criteria defined by the frailty phenotype. One of the subjects was eliminated from the study because he didn't meet all of these criteria. In order to understand phenotypic frailty by gender and age, we categorize age in 3 groups 50 - 64 years, 65 - 74 years and 75 years and over. In Figure 1 we can see a similar distribution of frailty levels by gender, except in the condition of frailty, where there are 40.9% of women. Regarding the distribution of frailty by age groups, we can observe that frailty is higher as age progresses. Everyone over 75 years is frail, 37,7 people are pre - frail and 60,4% are frail individuals. In the age group 65-74 years, the most prevalent conditions are pre-frail and frail, with 44.1% and 45.2% respectively, and only 10.8% individuals are not frail. In the youngest age group, 50-64 years, the majority are pre-frail (57.5%), with the remaining cases distributed equally among the frail (20.0%) and not frail (22.5%).

Figure 1 – Distribution of phenotypic frailty by gender and age.



Predictor model of frailty

The groups of explanatory variables were first introduced one by one in the model (Table 2). As for the sociodemographic variables, in the unadjusted model, all the variables of the study assume a significant association ($p < 0.05$) with frailty. According to the logistic regression model, adjusted to age and gender, frailty is predicted by gender ($p = 0.030$); age ($p < 0.001$); education ($p = 0.025$) and social relations ($p < 0.001$). The probability of women being frail is 1.7 times higher than in men (OR 1.7, 95% CI 1.0-2.8). The oldest subjects (≥ 65 years of age) are 2.8 times more likely to be frail compared to the younger ones (OR 2.8, 95% CI 1.6 - 4.9). Those who didn't attend school have 2.6 times more probability of becoming frail (OR 2.6, 95% CI 1.1-6.0) than those with education. Finally, maintaining social relationships seems to be a protective factor of frailty, because those who have a social network have 0,3 times less probability of becoming frail (OR 0.3, 95% CI 0.1 - 0.5).

Table 2 – Logistic Regression Model for frailty adjusted to the studied variables

	non adjusted OR (IC 95%)	p	Adjusted OR (IC 95%)	p
Sociodemographic variables				
Gender				
Male	1		1	
Female	1.7 (1.1-2.8)	0.000**	1.7(1.0-2.8)	0.030**
Age				
50 – 64 years	1		1	
≥ 65 years of age	3.5(2.2-5.6)	0.000**	2.8(1.6-4.9)	<0.001**
Education				
Attended school	1		1	
Didn't attend school	5.6 (2.6-11.1)	0.000**	2.6 (1.1-6.0)	0.025**
Family Situation				
Family with members with dependency	1		1	
Family without members with dependency	0.5 (0.3-0.9)	0.000**	0.9 (0.5-1.5)	0.828
Housing				
Inadequate to the needs	1		1	
Adequate to the needs	0.5(0.3-0.9)	0.000**	1.0 (0.6-1.9)	0.786
Social relations				
Social relations limited	1		1	
Social relations extensive	0.3 (0.1-0.5)	0.000**	0.3 (0.1-0.5)	<0.001**
Biobehavioural indicators				
Peak flow				
High	1		1	
Low	3.3 (1.9-5.7)	0.000**	3.3 (1.9-6.0)	<0.001**
Mobility (Speed)				
Without help	1		1	
With help	2.0 (0.9-4.2)	0.057*	1.2 (0.2-5.6)	0.816
Mobility (Climb stairs)				
No	1		1	

Yes	0.4 (0.1-1.1)	0.088*	0.6(0.1-1.9)	0.431
Geriatric Indicators				
Medication				
No	1		1	
Yes	2.1 (1.1-4.1)	0.024**	1.3 (0.6-2.8)	0.503
Falls (in last six months)				
No	1		1	
Yes	3.4 (1.9-5.9)	0.000**	3.0 (1.5-5.6)	0.001**
Urinary incontinence				
No	1		1	
Yes	1.8 (1.0-3.0)	0.021**	1.3 (0.7-2.5)	0.346
Constipation				
No	1		1	
Yes	2.2 (1.3-3.6)	0.001**	1.4 (0.8-2.7)	0.187
Sensorial impairments				
Hearing	2.2 (1.3-3.6)	0.002**	2.1(1.1-4.0)	0.014**
Vision	2.5 (1.5-4.2)	0.000**	2.1(1.2-3.8)	0.008**
Sleep (satisfaction)				
No	1		1	
Yes	0.6 (0.4-1.0)	0.076*	0.8 (0.4-1.4)	0.508
Comorbidities				
No	1		1	
Yes	2.0 (1.2- 3.2)**	0.003**	1.8 (1.0-3.2)	0.030**
Functioning				
ADL				
Dependent on ADL	1		1	
Independent on ADL	0.2 (0.1-0.6)	0.005**	0.4 (0.1- 1.1)	0.102
IADL				
Capable on IADL	1		1	
Incapable on IADL	2.3 (1.4- 3.7)	0.001**	2.1 (1.2-3.5)	0.004**
Mental health				
Cognitive deterioration				
Without deficit	1		1	
With deficit	3.8 (2.3-6.3)	0.000**	2.9 (1.6-5.3)	<0.001**
Mood				
Without depressive symptomatology	1		1	
With depressive symptomatology	4.7 (2.2-10.0)	0.000**	4.2(1.9-9.2)	<0.001**
Self-perception of health and Quality of Life				
Health Self-perception				
Bad	1		1	
Good	0.2 (0.1-0.3)	0.024**	0.4 (0.1-0.9)	0.029**
Life quality				
Physical domain				
High	1		1	
Low	4.1(2.5-6.6)	0.000**	2.9 (1.5-5.5)	0.001**
Average	0.8 (0.5-1.3)	0.595	0.9(0.6-1.6)	0.940
Psychological domain				
High	1		1	
Low	3.2 (2.0-5.0)	0.000**	2.7 (1.4-5.3)	0.003**
Average	0.7 (0.5-1.1)	0.154	0.6 (0.4-1.1)	0.143
Social domain				
High	1		1	
Low	1.9 (1.0-3.5)	0.030**	0.5 (0.2- 1.3)	0.204
Average	0.9(0.5-1.4)	0.736	1.1 (0.6-2.0)	0.677
Environmental domain				
High	1		1	
Low	1.5 (0.9-2.3)	0.054*	0.7 (0.3-1.3)	0.337
Average	0.9 (0.6-1.3)	0.735	0.9 (0.6-1.4)	0.866

**p <0.05; * p <0.1

We can see that all the bio behavioural indicators were related to the condition of frailty. In the adjusted model of frailty, the peak flow is the only indicator (OR 3.3, 95% CI 1.9 - 6.0) which reveals to be statistically significant for the condition of frail elder ($p < 0.001$). At the level of geriatric indicators, it was found that all of them relate positively with frailty, except for sleep (sleep satisfaction), with a significance level of 90%. In the adjusted model for geriatric indicators are statistically significant: subjects who have fallen in the past 6 months, have 3.0 times more probability of being frail (OR 3.0, 95% CI 1.5 - 5.6); change of sensory processes is positively associated with the condition of frailty, since the subjects who have disturbances at the hearing level are 2.1 times more likely to be frail (OR 2.1, 95% CI 1.1 - 4.0), as well as those who have vision problems that are 2.1 times more likely to be equally frail (OR 2.1, 95% CI 1.2 - 3.8); in elders who have one or more comorbidities, the probability of being frail is 1,8 times higher in comparison to those with no disease (OR 1.8, 95% CI 1.0 - 3.2). According to study about functionality, we can see that being unable or having some difficulty in IADL increases by 2.1 times the likelihood of the subjects being frail (OR 2.1, 95% CI 1.2 - 3.5). At the level of mental health (cognitive state and mood) both are significantly related to frailty in a statistically significant way ($p < 0.05$). People with cognitive impairment are 2.9 times more likely to be frail (OR 2.9, 95% CI 1.6 - 5.3). People with depressed mood are 4.2 times more likely to be frail (OR 4.2, 95% CI 1.9 - 9.2). Regarding health self-perception and quality of life the results showed that self-rated health and physical and psychological quality of life are associated with frailty ($p < 0.05$). Those who assess their health as good have 0,4 less probability of being frail (OR 0.4, 95% CI 0.1 - 0.9). In relation to the assessment of quality of life, the lower physical and psychological quality of life was, the higher the probability of frailty, respectively (OR 2.9, 95% CI 1.5 - 5.5), (OR 2.7, 95% CI 1.4 - 5.3).

Discussion

Regarding the prevalence of the frailty phenotype the impact of this syndrome is clear in the population, in which 34.9% were considered frail. As with other studies that have tested the frailty phenotype, this result is within the observed range that varies from 4.0 to 59.1% (Collard et al., 2012). However, we have to point out that the prevalence of frailty varies widely, depending on the definition of the concept, the assessment instrument, as well as the target population.

From the analysis we can identify three groups of factors which are predictive of frailty: *socio-demographic*, *bio behavioural and health*, and *psychosocial*. In the context of demographic factors, we highlight gender (being a woman), age (older), and education (no education). Those which best predict frailty are old age (OR 2.8, 95% CI 1.6 - 4.9) and lack of education (OR 2.6, 95% CI 1.1 - 6.0). Finally, the fact of being a woman is also considered a predictor factor (OR 1.7, 95% CI 1.0 - 2.8). This set of factors is eventually interlinked because it is known that the more years of age, the greater the risk of being frail (Collard et al., 2012). Moreover, it is also known that women live longer, so they are more exposed to the criteria of frailty. Regarding the educational level, it makes sense to be considered a predictor factor of phenotypic frailty, since cognitive functioning itself (deficit) is also considered a factor that predicts this condition. From our point of view, these two factors, level of education and cognitive performance, reinforce each other, as promoters of frailty.

At the bio behavioural and health levels there are indicators of bio behavioural nature, geriatric indicators and functionality of the subject. In this context, we highlight the low peak flow (OR 3.3, 95% CI 1.9 - 6.0) as a predictor of frailty. From the point of view of functioning, it stands out the changes in sensory processes, including vision (OR 2.1, 95% CI 1.2 - 3.8) and hearing (OR 2.1 95% CI 1.1 - 4.0) as factors that predict the condition of frailty, as well as the presence of falls in the previous 6 months (OR 3.0, 95% CI 1.5 - 5.6) and having at least one pathology (OR 1.8, 95% CI 1.0 - 3.2). Functional impairment was identified as a predictor factor of frailty (OR 2.1, 95% CI 1.2 - 3, 5).

Finally, in the psychosocial domain, the cognitive impairment (OR 2.9, 95% CI 1.6 - 5.3) and depressive symptoms (OR 4.2, 95% CI 1.9 - 4.2) enhanced frailty. It is worth highlighting the weight of the predictive value of mood for the condition of a frail elder, in which the probability of a person with a depressive symptomatology being frail is 4.2 times higher. In this study, it is the indicator with the highest predictive value, which reflects the importance of the affective and emotional conditions of the subject, as contributing value of some stability at the physical and functional level of the individual. In fact, the literature assumes a bidirectional relationship between depression and frailty (Mezuk et al., 2012). Several cross-sectional and cohort studies widen this two-way relationship. Nevertheless, it is clear the association between the manifestation of depressive symptoms and the condition of frailty. It is important to highlight that these two conditions assume predictive values due to the same kind of results, including: cognitive impairment (Andersen et al., 2005), disability (Bruce, 2001), fractures (Whooly et al., 1999) and mortality (Rovner et al., 1991; Laursen et al., 2007). In light of cross-sectional studies arises the empirical work of Chang et al. (2010) that tests the frailty phenotype and its relationship to mood. It should be stressed that the instruments that measured depression were different, one was based on the GDS - Geriatric Depression Scale and the other on the CES-D - Centre for Epidemiologic Studies - Depression Scale, respectively. However, both came to the same conclusion, that the indicator of depression was considered a determining factor for the condition of frailty, as it was proven that depressive symptoms were significantly associated with the condition of frailty. On the contrary, in longitudinal studies, it was found that the presence of depressive symptoms isn't always associated with frailty (Ostir et al., 2004)

and based on the Cardiovascular Health Study (with modified items of the frailty phenotype) concluded that depressive symptoms were not associated with the incidence of frailty. In 2007, the empirical work of Xue et al. (2007) adds that depressive symptoms were not significantly associated with the incidence of frailty but with mortality. Within the scientific community there is no consensus regarding the clear definition and relationship between these two conditions. With respect to the predictive value of the cognitive pattern for frailty, we can see in this study that those who have cognitive impairment have 2.9 times more probability of being frail. The literature supports this same premise, with a set of studies in this area (Strawbridge et al., 1998; Gill et al., 1999; Ávila-Funes et al., 2009).

Regarding the study of quality of life, this acts as a mirror of the physical and psychological condition of the subject and when these dimensions are negative, act as predictors of frailty (OR 2.9, 95% CI 1.5 - 5.5) (OR 2.7, 95% CI 1.4 - 5.3), respectively. It seems that the frailty syndrome may depend on subjective aspects, like negative self-assessment of certain dimensions of life. In the study - Hispanic Established Populations Epidemiologic Studies of the Elderly (HOPE) (Graham et al., 2009) the authors concluded that the condition of frail and pre-frail elder was associated with low levels of physical and cognitive conditions. The studies of Puts et al. (2007) assume that the experience of living in a condition of frailty leads to poor quality of life.

Taking into account the protective factors of frailty, we stress two psychosocial aspects: having a social network (OR 0.3, 95% CI 0.1 - 0.5) and a good health self-perception (OR 0.4, 95% CI 0.1 - 0.9) are factors that act as protectors of the condition of frail person. Thus, maintaining an elder socially active, in such a way that it allows him to sustain interpersonal relationships and provide him with tools to better assess his health, work as factors that protect the elderly person from the frailty condition. In the studies of Sydall et al (2009) it is proven the link between the maintenance of social relationships and the condition of frailty.

Conclusion

In general, we identify a set of sociodemographic, bio behavioural and health indicators, as well as of psychosocial variables that predict phenotypic frailty. We also found indicators that are protectors of frailty. Thus, we observe a multiplicity of factors that affect the condition of the frail elder who deserves further attention, so that we can intervene appropriately in order to prevent or decrease this syndrome in the elderly.

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