Frailty, body composition and nutritional status in non-institutionalised elderly

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ORIGINAL ARTICLE

Frailty, body composition and nutritional status in non-institutionalised elderly[☆]

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Abstract

Objective: Frailty is a clinical syndrome characterised, among other signs, by involuntary weight loss and decreased muscle strength. The aim of this study was to analyse associations between frailty, body composition and nutritional status in non-institutionalised elderly people in the municipality of Alfândega (Braganza-Portugal).

Method: Observational, prevalence and association study involving 220 elderly (mean 75.8 ± 6.8 years of age; 68.8% women). Frailty was assessed according to Fried criteria, body composition by bioelectrical impedance analysis and nutritional status using the Mini Nutritional Assessment Short-Form.

Results: The prevalence of frailty was 23.6%. Frail participants had, on average, lower total muscle mass and lower segmental muscle mass (arms and legs) than pre-frail and non-frail ($p < 0.001$). From the elderly at risk of malnutrition or undernourished ($n = 24$), the majority ($n = 13$) had frailty syndrome. It was observed that 41.2% of the elderly with low weight were frail. This syndrome prevailed only in 17.1% of the eutrophic persons, increasing again to 22.4% in the overweight group ($p < 0.001$).

Conclusion: The phenotypic profile of frail elderly was characterised by lower muscle mass. The results of our study suggest that both underweight and overweight may be associated with frailty. There is the need to prevent and manage frailty, not only taking into account possible

treatable medical causes, but also by intervening in important pillars, such as physical activity, dietary and nutritional problems.

Fragilidad, composición corporal y estado nutricional en ancianos no institucionalizados

Resumen
Objetivo: La fragilidad es un síndrome clínico caracterizado, entre otros signos, por la pérdida involuntaria de peso y fuerza muscular disminuida. El objetivo de este estudio fue analizar asociaciones entre fragilidad, composición corporal y estado nutricional en ancianos no institucionalizados del municipio de Alfândega (Braganza-Portugal).
Método: Estudio observacional, de prevalencia y asociación cruzada en el que participaron 220 ancianos (edad media de 75,8 ± 6,8 años; 68,8% mujeres). La fragilidad fue evaluada según el fenotipo de Fried, la composición corporal por impedancia bioeléctrica y el estado nutricional mediante el *Mini Nutritional Assessment Short-Form*.
Resultados: La prevalencia de fragilidad fue del 23,6%. Los participantes frágiles presentaban, en promedio, menor masa muscular total y menor masa muscular por segmentos (brazos y piernas) que los prefrágiles y no frágiles (p < 0,001). De aquellos ancianos en riesgo de desnutrición o desnutridos (n = 24), la mayoría (n = 13) presentaban síndrome de fragilidad. Se observó que el 41,2% de los ancianos con bajo peso eran frágiles. Dicho síndrome prevaleció tan solo en el 17,1% de las personas eutróficas, aumentando de nuevo al 22,4% en el grupo con sobrepeso (p < 0,001).
Conclusión: El perfil fenotípico de los ancianos frágiles se caracterizó por menor masa muscular. Los resultados de nuestro estudio sugieren que tanto el bajo peso como el sobrepeso podrán conducir a situaciones de fragilidad. Es fundamental prevenir y gestionar la fragilidad, no solo teniendo en cuenta las posibles causas médicas tratables, sino también interviniendo en pilares importantes, como la actividad física y los problemas dietéticos y nutricionales.

What is known?

Multiple organic and systemic changes taking place during the ageing process are reflected in body composition and nutritional status of the elderly.

With regards to body composition, studies report a lower muscle and bone mass which in turn affects muscle strength and increases functional deterioration. Moreover, nutritional status affects the health and quality of life of elderly people.

Both sarcopenia and malnutrition may lead to frailty in the elderly and are commonly found problems in the geriatric population. In accordance with the phenotype developed by Linda Fried, frailty in the elderly is a clinical syndrome which is identifiable by the presence of at least 3 of the following criteria: involuntary weight loss, fatigue/exhaustion, reduced physical activity, slowness in walking and decreased muscle strength.

Since the phenotype model assesses clinical criteria which is closely linked with sarcopenia, research incorporating clarifying variables of the model itself is necessary, together with those governing body composition and nutritional status.

What does this paper contribute?

This research study is a contribution to previously provided evidence of aspects which have not been investigated in depth before, such as the prevalence of frailty in the Portuguese elderly and especially the results of the various components of body composition (muscle mass, bone mass, fat and water in the body) differentiating between non-frail, pre-frail and frail elderly people.

Study findings outline the need for preventing and managing frailty, not just taking into account chronic illnesses, but also assessing the promotion of physical activity and dietary and nutritional problems.

Together with the rest of the evidence, results may contribute to the design of interventional and active ageing programmes for the elderly.

Introduction

Frailty is a geriatric syndrome characterised by the loss of reserves and energy in many organs and systems, which have lost their homeostatic capacity to deal with the stressful events of everyday life.[1] Although there is no standard diagnosis for the frail elderly person, we put forward the

hypothesis that the negative energy balance resulting from this state, is observable from a phenotype which includes a combination of signs and symptoms such as weight loss, fatigue, reduced physical activity, reduction in walking speed and muscle weakness.[2,3]

In general it is accepted that frailty is a clinical syndrome which is different from functional inability and which increases the risk of adverse events, such as falls, functional impairment or institutionalisation. Consensus has it that its impact may be reversed or attenuated through appropriate intervention and that early recognition is essential for the elderly person's health.[4] There is evidence that the frailty syndrome is more common in women, increases with age, with the presence of comorbiditites and polypharmacy,[3] its prevalence in Spain ranges between 8.5% and 20.4%,[5,6] similar to that reported in other countries in the south of Europe, such as France (15.0%), Greece (14.7%) or Italy (27.3%).[7]

Although during recent years evidence regarding the frailty syndrome has risen considerably, there are no known cohort studies in Portugal, providing us with precise evidence as to frequency. Follow-up studies of frail populations and studies which evaluate intervention programmes are also infrequent in international literature.[1,3] Furthermore, since the phenotype model assesses physical issues highly linked with sarcopenia,[2] there is a need for more research studies to incorporate variables which clarify the model itself, such as body composition and nutritional status.

It is known that during the ageing process changes in body composition occur which affect autonomy and how the body functions,[8] and that rehabilitation and physical exercise programmes improve functional apptitude.[9] From the fourth decade of life onwards, muscle mass (MM) begins to decline, especially in sedentary people. The reduction in MM is usually replaced by an increase in fat, which is reflected in the body mass index (BMI). This normally rises up to 70–75 years of age, and then drops.[10] Bone mineral density increases up to the third decade of life, after which it is progressively decreases. Osteopenia is a process which affects women more but from 70 years onwards, bone loss increases equally in both men and women.[11] Body water is an essential nutrient in all life stages. It progressively decreases in old age and in the most elderly this reduction is associated with other environmental and health variables and may lead to electrolyte imbalances, which is a major cause of hospitalisation of the elderly.

Based on evidence, we may infer that a good nutritional state and regular physical activity, contribute to the maintenance of a neuromuscle and appropriate cognitive balance, prevent weight loss and the reduction of muscle mass and strength, the determining components of frailty.[12]

In the light of all of the above we conducted a study, the main purpose of which was to analyse possible associations between frailty, body composition and nutritional status in non-institutionalised elderly people. Specific objectives were as follows: (1) characterise the participants in accordance with socio-demographic variables; (2) estimate the prevalence of frailty; (3) compare the parameters of body composition according to the different levels of frailty; (4) assess nutritional status and its association with frailty.

Method

To achieve the objectives an observational, prevalence and association cross study was designed, which was conducted in the municipality of Alfândela (province of Braganza-Portugal). According to the latest census, this community had 1660 inhabitants over 65 years of age, distributed into 12 towns. Simple and proportional random sampled selection was made, with regard to the proportion of elderly people in each town. Confidence level was 95%, sample error 5% and population homogeneity 80/20. Exclusion criteria of the sample were the inability to walk independently and the presence of serious cognitive impairment, assessed by the *Short Portable Mental Status Questionnaire*.[13] The final sample comprised 220 elderly people.

Data was collected using a socio-demographic and clinical questionnaire with consideration of the following variables: gender, marital status (single, married, divorced/separated, and widowed); age, cohabitation (lives alone, lives with the family); self-perceived health (very good, good, OK, bad); BMI; body composition, nutritional status and frailty.

Body composition was analysed using the Tanita BC-545 bioelectrical impedence analysis scale. Analyses were made during the morning, whilst fasting, and with an empty bladder. Stature was assessed using a stadiometer and for BMI classification, Lipschitz recommended cut off points and categories for elderly people were followed[14]: underweight (BMI < 22 kg/m^2), eutrophy (BMI 22–27 kg/m^2) and obesity (BMI > 27 kg/m^2).

Nutritional status was assessed using the *Mini Nutritional Assessment Short-Form* (MNA-SF). This tool is recommended by the European Society of Clinical Nutrition and Metabolism for evaluating the risk of malnutrition in elderly people and its diagnostic capacity has been well documented in previous studies.[15] The MNA-SF is a simple, non invasive tool which has been validated in several countries, including Portugal.[16] The tool determines the nutritional status based on 8 scorable items, and the final summary of which may reach a maximum of 14 points. Screening values between 12 and 14 points indicate a normal nutritional status, between 8 and 11 indicate a risk of malnutrition and scores of 7 or under indicate malnutrition.

Frailty was assessed according to the frailty phenotype proposed by Linda Fried.[2] According to this reference the following criteria were assessed: (1) unintentional weight loss over 4.5 kg or above 5% of body mass over the last year; (2) self-report on fatigue/exhaustion; (3) reduced physical activity; (4) low walking speed; (5) reduction of muscle strength. The elderly who met three or more criteria were classified as frail, in the presence of one or two as pre-frail and in the absence of criteria as not frail or robust.

Unintentional weight loss of over 4.5 kg or 5% of body weight was assessed comparing the result obtained in the balance of body composition with that stated by the person the previous year.[2]

Fatigue/exhaustion was evaluated through two questions on the *Centre for Epidemiologic Studies Depression Scale*[17] questionnaire. This questionnaire is often used to measure depressive symptomology and in particular this phenotype criteria,[2] with two specific questions about the previous week: ''did you feel that everything you did was an effort?''

and ''did you feel that you did not want to do anything?'' In keeping with recommended methodology,[2] fatigue was present when the participants responded in the affirmative for three or more days of the week.

Reduced physical activity was assessed using the *Minnesota Leisure Time Activities*, a questionnaire designed by the American College of Sports Medicine.[18] Depending on energy output, individuals were classified as moderately active, active and very active. When they were classified as sedentary or moderately active the existence of this phenotype criterion was considered.

Speed of walking was chronometrically assessed as the time spent for a distance of 4.57 m and results were adjusted according to gender and stature, in keeping with Fried's protocol.[2] To assess Muscle strength, a gripping strength test was made, using the JAMAE balancing machine, with the dominant hand. Results were recorded in kg of strength (kgs) and adjusted according to gender and BMI. Participants were distributed in this criterion according to the cut off points described in the literature.[2]

Data collection was made during the first half of 2016, in town council premises with the town councils that had participated. Data was collected by researchers who had previously standardised protocols to minimise possible measurement biases. Ethical procedures were followed in keeping with the declaration of Helsinki. The research study was approved by the Ethics Committee of the Senior Nursing College in Coimbra (no. 318/2015) and all participants signed informed consent forms.

The software *Statistical Package for the Social Sciences* (SPSS, version 21) was used, with standard procedures of descriptive and analytical statistics. Quantitative variables were expressed as mean and standard deviation and qualitative data as percentages. Comparison of quantitative variables according to the groups of variable frailty was used in the analysis of variance (ANOVA). To compare qualitative variables and frailty status the Chi squared test was used. The following value was considered significant: $p < 0.05$.

Results

Table 1 lists the socio-demographic and clinical characteristics of 220 elderly people. The predominance of women in the sample stood out (68.6%). The high percentage of participants who stated they lived alone (30.5%) was also high as was the fact that only 18.6% perceived themselves as having a good state of health. Average age was 75.8 years. The prevalence of frailty was 23.6%. The other elderly people were classified as pre-frail (42.7%) and not frail (33.6%).

As suggested by Table 2, the percentage of fat did not vary significantly between the different levels of frailty ($p = 0.742$). Similarly, there were no significant changes in bone mass with regards to the diagnosis of frailty ($p = 0.404$). Results obtained for body water ($p = 0.222$) may be interpreted in the same way. On the contrary, in total MM, the non frail individuals managed 46.9 kg, compared with 41.9 kg in the pre-frail and 40.0 kg in the frail ($p < 0.001$). All results obtained in the MM, in arm and leg segments, had higher scores in the non frail elderly ($p < 0.001$).

With regard to the proportion of individuals by BMI category and frailty diagnosis (Table 3) it was noted that 41.2% of

Table 1 Socio-demographic and clinical characteristics of the elderly people.

	Participants (n = 220)
Gender, n (%)	
Women	151 (68.6)
Men	69 (31.4)
Marital status, n (%)	
Single	5 (2.3)
Married	127 (57.7)
Divorced/separated	2 (0.9)
Widow	86 (39.1)
Cohabitation, n (%)	
Lives alone	67 (30.5)
Lives with the family	153 (69.5)
Self-perception of health, n (%)	
Very good	0 (0.0)
Good	41 (18.6)
OK	143 (65.0)
Bad	36 (16.4)
Frailty, n (%)	
Not frail	74 (33.6)
Pre frail	94 (42.7)
Frail	52 (23.6)
Age in years, mean ± SD	75.8 ± 6.9

SD: standard deviation.

the elderly classified with low weight presented with frailty. In contrast, frailty only prevailed in 17.1% of eutrophic people, increasing again to 22.4% in the overweight group ($p < 0.001$).

Regarding nutritional status, the prevalence of frailty was higher in the elderly at risk of malnutrition or undernourishment (54.2%), when we compared them with those verified in well nourished elderly (19.9%). The association between the variables is statistically significant ($p < 0.001$). Moreover, comparing the means obtained in the MNA-SF for the variable frailty (Table 3), the mean was 13.9 for non frail participants, 13.3 for pre-frail participants and 12.5 for the frail ($p < 0.001$).

Discussion

This study sought to analyse associations between frailty, body composition and nutritional status in elderly people who lived at home. Socio-demographics revealed that the sample mean age was above 75, mostly female and had a tendency to be vulnerable, which was confirmed by previous demographic reports carried out in Portugal.[19]

A frailty prevalence of 23.6% was found, higher than that confirmed in the majority of epidemiological studies carried out in other European countries.[7] Due to the rapid ageing of the population, it is equally important to carefully observe the prevalence of pre-frailty (42.7%) and consider that many of these elderly people could become frail, as age and its associated comorbidity increases.[5] In fact, further longitudinal studies are required in this area, in addition to intervention and research/health action studies to enable

Table 2 Body composition according to frailty status.

	Not frail Mean ± SD	Pre-frail Mean ± SD	Frail Mean ± SD	Total Mean ± SD	p[a]
Body fat (%)	30.0 ± 7.6	30.8 ± 7.2	30.7 ± 8.2	30.5 ± 7.5	0.742
Trunk fat (%)	27.2 ± 7.1	27.0 ± 7.5	26.3 ± 8.3	26.9 ± 7.5	0.791
Bone mass (kg)	2.5 ± 0.5	2.5 ± 2.2	2.2 ± 0.4	2.4 ± 1.5	0.404
Total Muscle mass (kg)	46.9 ± 9.2	41.9 ± 7.0	40.0 ± 7.1	43.3 ± 8.3	<0.001
Muscle mass RA (kg)	2.7 ± 0.8	2.2 ± 0.5	2.1 ± 0.4	2.4 ± 0.6	<0.001
Muscle mass LA (kg)	2.5 ± 0.7	2.2 ± 0.4	2.1 ± 0.4	2.3 ± 0.6	<0.001
Muscle mass RILL (kg)	7.4 ± 1.5	6.7 ± 1.1	6.3 ± 1.3	6.9 ± 1.4	<0.001
Muscle mass LL (kg)	7.5 ± 1.6	6.8 ± 1.1	6.5 ± 1.3	6.9 ± 1.4	<0.001
Body water (%)	50.6 ± 5.4	49.3 ± 4.7	49.4 ± 5.3	49.7 ± 5.1	0.222

RA: right arm; LA: left arm; SD: standard deviation; kg: kilograms; RL: right leg; LL: left leg.
[a] Using the Anova test.

Table 3 Body mass index and nutritional status according to frailty status.

	Not frail n (%)	Pre-frail n (%)	Frails n (%)	Total n (%)	p[a]
BMI					<0.001
Underweight	5 (14.7)	15 (44.1)	14 (41.2)	34 (100.0)	
Eutrophic	24 (34.3)	34 (48.6)	12 (17.1)	70 (100.0)	
Overweight	45 (38.8)	45 (38.8)	26 (22.4)	116 (100.0)	
MNA-SF					<0.001
Well nourished	72 (36.7)	85 (43.4)	39 (19.9)	196 (100.0)	
Risk of malnutrition and undernourished	2 (8.3)	9 (37.5)	13 (54.2)	24 (100.0)	

	Not frail Mean ± SD	Pre-frail Mean ± SD	Frail Mean ± SD	Total Mean ± SD	p[b]
Weight (kg)	70.7 ± 1.2	64.3 ± 10.9	62.6 ± 14.2	66.1 ± 12.6	<0.001
Height (m)	1.59 ± 0.09	1.56 ± 0.08	1.53 ± 0.10	1.56 ± 0.09	<0.001
Total of BMI (kg/m²)	28.0 ± 4.3	26.5 ± 4.1	26.7 ± 5.6	27.0 ± 4.6	0.089
Total of MNA-SF	13.9 ± 0.6	13.3 ± 1.2	12.5 ± 1.9	13.3 ± 1.3	<0.001

SD: standard deviation; BMI: body mass index; kg: kilograms; kg/m²: kilograms/stature in square metres; m: metres; MNA-SF: *Mini Nutritional Assessment Short Form*.
[a] Using the Chi-squared test.
[b] Using the Anova test.

prevention of the frailty syndrome. In our opinion, social and health policies should enhance the aim of keeping elderly people integrated into their families and communities, with good quality of life and well-being, for as long as possible.

With regards to body composition analysis with the different levels of frailty, the most outstanding findings was that the phenotype profile of frail elderly people is characterised by lower total MM and by segments. The few studies which have analysed this association obtained similar findings.[20,21] In Fried's proposed cycle of neuroendocrine deregulation sarcopenia reduces muscle strength, which can have a negative effect on several phenotype characteristics, such as the isometric strength of the hand or speed of walking. Several works suggest that reduction of MM is a determining feature in the loss of manual pressure strength.[8,22,23] Physical training and rehabilitation programmes minimise functional impairment and improve hand strength.[9] For health professionals these facts underline the importance of preventing

frailty not just through the management of chronic diseases but also through recommendation of physical activity, with emphasis on muscle strength and resistance, particularly of the hand-arm segment, which is essential for successful execution of daily activities. The World Health Organisation (WHO) provides guidelines on physical activity for elderly people which, together with intervention and specific exercises in the area of frailty[24] could serve as orientative guides for creating programmes of prevention.

With regards to BMi, a statistically significant association was observed between its classification and the state of frailty. By analysing the information in greater detail, we found that 41.2% of elderly people with low weight were frail, but that a significant proportion of individuals who were overweight (22.4%) were also frail. Data appear to indicate that both under and overweight could lead to situations of frailty and bidirectionality which were also outlined in previous studies.[3,25] This suggests that the association

between BMI/frailty may go both ways, one related to low weight and sarcopenia and the other with sarcopenic obesity.

Findings from our study show a clear association between MNA-SF and phenotype frailty. It is well known that a healthy diet is a determining feature of human health and that ageing is a nutritionally vulnerable period in one's life. The lowering in the number of taste buds, loss of teeth, reduction in secretion by supplementary digestive tract glands, reduction in baseline metabolism, among others, exposes the elderly person to a higher nutritional risk associated with health. In the phenotype model of frailty, the nutritional status may affect two essential conditions: unintentional weight loss and fatigue/exhaustion.[2]

A recent review based on 32 articles concluded that malnutrition is a significant risk factor in the development of frailty syndrome.[26] However, a balanced and moderately hyper protein diet, combined with calcium and vitamin D supplements, appears to improve bone and muscle health and reduce the risk of falls and fractures in frail elderly people.[26] In the elderly population, in general, a varied Mediterranean style diet, rich in proteins, micronutrients and vitamin D may help to maintain an appropriate neuromuscular balance and reduce the risk of frailty.[26,27]

We underline the need to prevent and manage frailty, not only by taking into account the possible treatable medical causes, but also intervening in important pillars, such as physical activity and nutritional problems. Nurses play a major role in these interdisciplinary interventions and should actively participate in decision-making on healthy ageing policies.

The main limitation to this research is its transversal nature, which prevents us, for example, from verifying how the variables studied could have an influence on frailty and its adverse events. A further limitation to the study was not knowing the weight of the sample a year before the study, due to the fact that this information was collected from the individuals themselves and was therefore subjective. However, the study offers information on little known research on the frailty syndrome in Portugal. It also discloses analysis on the different body composition components differentiated by stages of frailty, which little research had previously covered. Finally, research findings could contribute to the design of intervention and active ageing programmes.

Conflict of interests

The authors have no conflict of interests to declare.

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