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Posted Date: 20 November 2025

doi: 10.20944/preprints202511.1565.v1

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Article

Associations Between Frailty, Body Mass Index, and Functional Fitness in Older Women

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Abstract

Objective: To analyze the differences in body mass index (BMI) and functional fitness tests between women with and without frailty, and secondarily to determine whether frailty is related to functional fitness performance in elderly women. **Methodology:** A cross-sectional study was conducted in 69 women aged 60 to 85 years. Weight, height and body mass index (BMI) were assessed. The Senior Fitness Test battery was used to assess functional fitness. Frailty was assessed through the Kihon Checklist (KCL) questionnaire. **Results:** There were significant differences ($p < .05$) between women with and without frailty in the sit to stand up from a chair, biceps curl and 2.44m agility tests. There were no significant differences between both groups in age, BMI, chair trunk flexion, 6-minute walk, 2-minute walk, right and left hand grip strength ($p > .05$). Significant positive correlation was determined between age and frailty ($r = .359$, $p = .003$). However, negative correlations were observed with functional fitness tests, including sitting and rising from a chair, biceps curl, trunk flexion in chair, join hands behind back, 2.44 m agility, 6-min walk, and right hand-grip strength, with values ranging from $r = -.386$ to $r = -.268$. No significant correlation was found with the walk test. **Conclusion:** The study showed significant differences in BMI and functional fitness tests between women with and without frailty. As women age, frailty increases and functional fitness decreases, especially in key tests, which may be useful in assessing fall risk and functional status in women aged 65-85 years.

Keywords: aging; elderly women; frailty; physical fitness

1. Introduction

Frailty is a dynamic clinical condition characterized by diminished functional reserve, which increases an individual's vulnerability to adverse health outcomes.[1]. This syndrome reflects the depletion of physiological reserves, deterioration of biological systems, and heightened susceptibility to negative events, closely tied to the aging process [2]. As a reversible geriatric syndrome, frailty has emerged as a major public health challenge worldwide. [3].

Older adults with frailty face a substantially higher risk of mortality compared with their non-frail counterparts, regardless of factors such as age, sex, cognitive impairment, or socioeconomic status [4,5] They also face difficulties in maintaining independent functioning, which can result in a state of functional incompetence [6], with frailty considered a primary pathway to disability [7].

Consequently, at advanced ages, older adults of both sexes, especially women, show a decline in functional capacity and life expectancy, which has now become a critical challenge for countries with aging populations. [8].

In Chile, reported frailty prevalence rates vary widely across studies. Some research has found prevalence as high as 52% [9], while other national data show an overall prevalence of 10.9%, with higher rates in women (14.1%) compared with men (7.7%) [10]. These disparities highlight the methodological and demographic factors that influence frailty estimates. Despite these differences, projections indicate that the number of frail older adults will increase proportionally as the Chilean population continues to age. [11].

Multiple factors have been associated with the development of frailty, including sociodemographic characteristics, poor sleep, reduced ability to perform daily activities, physical inactivity, and chronic health conditions [12]. Studies have demonstrated that the likelihood of frailty is higher among women with lower socioeconomic status [13,14], conferring an intrinsic susceptibility to frailty given that they typically exhibit lower lean mass and muscle strength than age-matched men. This disparity subsequently results in a higher frailty index, as women experience greater age-related declines in lean mass [13,15]. However, certain extrinsic factors also increase vulnerability to frailty. For example, older women are more likely to have inadequate nutritional intake compared with men, as they often live alone [16].

Frailty is also associated with risk factors for physical health, specifically cardiopulmonary endurance and lower-limb performance, underscoring the importance of a comprehensive assessment of risk factors, which enables more precise decision-making in the prevention and management of frailty [17].

Studying frailty in older women is particularly important, as they exhibit higher prevalence and are at greater risk of adverse outcomes, including loss of independence, reduced quality of life, and increased mortality [15]. Biological and social differences between sexes may influence frailty onset and progression, highlighting the need to understand these factors for the development of more effective, tailored interventions.

Overall, scientific evidence shows that frail older adults are weaker, slower, and less vigorous than their counterparts and may experience sarcopenia and exhaustion, leading to avoidance of daily activities, progressive physical decline, and increased susceptibility to recurrent falls [18]. Moreover, given that frailty prevalence is higher in women than in men [15], they also face a greater risk of developing deficits in activities of daily living [19].

On the other hand, physical inactivity and social isolation are common factors in the aging of older adults, often resulting in decreased muscle strength and mass, accelerating frailty, and exacerbating chronic health conditions such as hypertension, cardiovascular and cerebrovascular diseases, diabetes, depression, and dementia [8].

In summary, there is a high prevalence of frailty among older adults, particularly women, which is associated with decreased functional capacity, increased susceptibility to adverse health events, and reduced life expectancy. However, methodological differences across studies reported in Chile reflect variability in frailty prevalence estimates, highlighting the need for a better understanding of the factors influencing frailty, particularly in women, in order to develop more effective interventions.

Therefore, the aim of this study was to analyze differences in body mass index (BMI) and functional fitness tests between women with and without frailty, and secondarily, to determine whether frailty is associated with functional fitness performance in older women.

2. Materials and Methods

2.1. Study Design and Sample

A cross-sectional (comparative) study was conducted with 67 older women, with a mean age of 71.52 ± 6.77 years. The sample was selected using a non-probabilistic convenience method.

Participants belonged to senior social groups in the city of Talca, Maule Region, and the city of Concepción, Biobío Region.

The study was conducted in accordance with the guidelines of the Declaration of Helsinki for human research [20] and followed the protocols approved by the Ethics Committee of Universidad San Sebastián (07-23). All older women who voluntarily agreed to participate and completed all functional fitness assessments and the frailty questionnaire were included. Participants with physical-motor problems or injuries that prevented them from performing the assessments were excluded.

2.2. Techniques and Procedures

Chronological age was calculated based on the participants' date of birth (day, month, year) and the date of the assessments. All evaluations were conducted at the facilities of the senior clubs in the region. Data collection took place in August and September 2023.

Anthropometric measurements were performed following the recommendations of Ross & Marfell-Jones [21]. Body weight (kg) was measured using an electronic scale (Tanita, UK) with a range of 0–150 kg and a precision of 100 g. Height was measured with a portable stadiometer (Seca GmbH & Co. KG, Hamburg, Germany) with a precision of 0.1 mm. Body mass index (BMI) was calculated using the formula: $BMI = \text{weight (kg)} / \text{height}^2 \text{ (m}^2\text{)}$.

Functional fitness was assessed using the Senior Fitness Test battery in its original version by Rikli & Jones [22]. This instrument evaluates muscle strength, aerobic endurance, flexibility, and agility in older adults through seven tests: chair stand, arm curl, chair sit-and-reach, back scratch, 8-foot up-and-go (2.44 m), 6-minute walk, and 2-minute step test.

Handgrip Strength was measured for both the right and left hands using a JAMAR (Hydraulic Hand Dynamometer® Model PC-5030 J1, Fred Sammons, Inc., Burr Ridge, IL, USA) with a precision of 0.1 lbf. Participants stood with their arms at their sides, shoulders in a neutral rotation, and elbows extended without touching the body during the grip. They were instructed to exert maximal grip force first with the right hand and then with the left. Two trials were performed for each hand, with a 1 minute rest between trials. The highest value obtained for each hand was recorded.

Frailty Assessment was conducted using the Spanish version of the Kihon Checklist (KCL) [23]. This questionnaire allows for the prediction of frailty in older adults and comprises 25 items across the following domains: 5 items on lifestyle, 5 on physical strength, 2 on nutritional status, 3 on oral function, 3 on home confinement, 3 on cognitive function, and 5 on risk of depression.

2.3. Statistical Analysis

Normality of the data was assessed using the Kolmogorov-Smirnov test. Descriptive statistics, including mean, standard deviation, and confidence intervals, were calculated. Differences in functional fitness between participants with and without frailty were analyzed using independent samples t-tests. Associations between functional fitness tests and frailty were examined using Spearman's rank correlation coefficient. A significance level of $p < 0.05$ was adopted for all analyses. Data were analyzed using Excel spreadsheets and SPSS® version 18.0.

3. Results

Table 1 presents the descriptive values of the anthropometric profile, functional fitness tests, and frailty measures in older women (mean age 71.52 ± 6.77 years).

Table 1. Anthropometric, Physical, and Functional Characteristics of the Study Sample.

| Variables | M | SD | CI |
|---------------------|-------|------|---------------|
| Age (years) | 71.52 | 6.77 | 69.87 – 73.17 |
| <i>Antropometry</i> | | | |

| | | | | |
|---------------------------|------------------------------|--------|-------|-----------------|
| | Weight(kg) | 69.72 | 11.71 | 66.85 – 72.57 |
| | | | | 151.09 – |
| | Height (cm) | 152.73 | 6.71 | 154.37 |
| | BMI (kg/mt ²) | 29.87 | 4.48 | 28.77 – 30.97 |
| <i>Frailty</i> | | | | |
| | Non-frail | 2.10 | 1.35 | 1.60 – 2.59 |
| | Frail | 8.75 | 2.86 | 7.78 – 9.72 |
| <i>Functional Fitness</i> | | | | |
| | Sit-to-Stand (sec) | 13.39 | 3.27 | 12.59 – 14.18 |
| | Biceps Curl (rep) | 19.69 | 6.48 | 18.10 – 21.27 |
| | Chair Trunk Flexion (cm) | 0.76 | 7.18 | -0.98 – 2.51 |
| | Back Scratch Test (cm) | -9.87 | 12.29 | - 12.86 - -6.87 |
| | 2.44 m Agility Test (sec) | 6.95 | 1.69 | 6.53 – 7.36 |
| | | | | 423.53 – |
| | 6-Minute Walk (m) | 440.51 | 69.56 | 457.48 |
| | 2-Minute Step Test (rep) | 85.42 | 24.15 | 79.52 – 91.31 |
| | Right Handgrip Strength (kg) | 49.96 | 9.84 | 47.55 – 52.35 |
| | Left Handgrip Strength (kg) | 48.27 | 10.04 | 45.82 – 50.72 |

M= mean; SD= standard deviation; IC= confidence interval.

Table 2 presents comparisons of BMI and functional fitness tests in women at risk of falling. No significant differences were observed between groups in age, BMI, chair sit-and-reach, 6-minute walk, 2-minute step, or right and left handgrip strength ($p > 0.05$). However, significant differences were found in the chair stand, biceps curl, and 8-foot up-and-go (2.44 m) tests ($p < 0.05$)

Table 2. Anthropometric, Physical, and Functional Characteristics of the Study Sample.

| Variables | Non-Frail (n=31) | | Frail (n=36) | | p | Cohen's d |
|----------------------------------|---------------------|-------|-----------------|-------|-------|--------------|
| | M | SD | M | SD | | |
| Age (years) | 69.87 | 5.99 | 72.94 | 7.16 | 0.060 | 0.46 |
| BMI (kg/m ²) | 29.03 | 4.57 | 30.60 | 4.33 | 0.158 | 0.35 |
| Chair Sit-to-Stand (sec) | 14.77 | 3.49 | 12.19 | 2.55 | 0.001 | -0.85 |
| Biceps Curl (rep) | 21.81 | 6.20 | 17.86 | 6.23 | 0.012 | -0.64 |
| Chair Trunk Flexion (cm) | 2.23 | 7.76 | -0.50 | 6.47 | 0.127 | -0.38 |
| Back Scratch Test (cm) | -7.61 | 10.13 | -11.81 | 13.73 | 0.156 | -0.34 |
| 2.44 m Agility Test (sec) | 6.47 | 1.49 | 7.36 | 1.76 | 0.030 | 0.54 |
| 6-Minute Walk (m) | 456.55 | 61.21 | 426.69 | 74.09 | 0.076 | -0.44 |
| 2-Minute Step Test (rep) | 89.39 | 20.42 | 82.00 | 26.77 | 0.206 | -0.31 |
| Handgrip Strength, Right (kg) | 52.32 | 10.79 | 47.92 | 8.57 | 0.072 | -0.46 |
| Handgrip Strength, Left (kg) | 49.81 | 10.92 | 46.94 | 9.16 | 0.254 | -0.29 |

M= mean; SD= standard deviation; BMI=Body Mass Index.

The relationships between BMI and functional fitness tests with frailty scale scores are presented in Table 3. Results indicate a significant positive correlation between age and frailty ($r = 0.359$, $p = 0.003$). Conversely, significant negative correlations were observed with the chair stand, biceps curl, chair sit-and-reach, back scratch, 8-foot up-and-go (2.44 m), 6-minute walk, and right-hand grip strength tests, with correlation coefficients ranging from $r = -0.386$ to -0.268 . No significant correlation was found with the 2-minute step test ($r = -0.182$).

Table 3. Relationship Between BMI and Functional Fitness Tests With Frailty.

| | Fragilidad | |
|------------------------------|------------|-------|
| | r | p |
| Age (years) | 0.359** | 0.003 |
| BMI (kg/m ²) | 0.192 | 0.120 |
| Sit-to-Stand Test (sec) | -0.380** | 0.001 |
| Biceps Curl (rep) | -0.386** | 0.001 |
| Chair Sit-and-Reach (cm) | -0.274* | 0.025 |
| Back Scratch Test (cm) | -0.268* | 0.028 |
| 2.44-m Agility Test (sec) | 0.346** | 0.004 |
| 6-Minute Walk (m) | -0.305* | 0.012 |
| 2-Minute Step Test (rep) | -0.182 | 0.140 |
| Right Handgrip Strength (kg) | -0.316** | 0.009 |
| Left Handgrip Strength (kg) | -0.202 | 0.102 |

** : Correlation is significant at the 0.01 level; *Correlation is significant at the 0.05 level.

4. Discussion

The aim of this study was to evaluate differences in BMI and functional fitness tests between women with and without frailty, and as a secondary objective, to analyze how frailty and functional fitness relate to aging in women aged 65 to 85 years. The results showed that women with frailty were older and performed worse on functional fitness tests such as the sit-to-stand test, biceps curl, chair sit-and-reach, back scratch test, agility test, 6-minute walk, and right-hand grip strength. In addition, the secondary analyses were consistent with these findings, demonstrating a positive correlation between frailty and age, and indicating that better performance in functional fitness was associated with lower frailty scores.

The findings of this study underscore the importance of functional assessment for identifying older women at risk of frailty and falls. These results are consistent with other cross-sectional studies conducted in older women from different populations [7,29–31], which report that frail older women tend to show weakness in strength tests, slower gait speed, and lower levels of physical activity [13]. These data reinforce the need for regular functional assessments and the implementation of exercise programs focused on strength and agility to reduce frailty and prevent falls in older women. Thus, developing intervention programs for this population focused on improving functional fitness not only optimizes balance and neurotransmitter function but also positively influences the maintenance of neuroendocrine and autonomic nervous system function, as well as brain morphology. This contributes to preventing frailty and fall risk in older women, thereby promoting a better quality of life in this age group [7,32].

Furthermore, based on these findings, a set of core recommendations has emerged in recent years, providing flexible implementation strategies that take into account both local context and the resources available for older adults [36]. Consequently, the U.S. Preventive Services Task Force [37] recommends engaging in physical exercise to prevent falls among community-dwelling adults aged 65 years and older who are at increased risk of falling. In this regard, recent studies have developed

several intervention programs with notable success, demonstrating reductions in fall risk and frailty [33–35]. These programs focus on fall prevention through multicomponent exercise interventions aimed at improving frailty status and reducing the risk of falls in older adults.

Although gains in strength have been documented in studies using isometric strength measurements [24,25], showing positive effects on balance [26] and mobility [27], the duration of these benefits in older women living at home remains uncertain. However, existing research suggests that positive outcomes tend to persist longer in community-dwelling older women [28].

Results Related to BMI and Handgrip Strength

This study presents several strengths, as it addressed a highly relevant public health issue by focusing on frailty and falls in older women, a particularly vulnerable demographic group. Additionally, the findings may serve as a baseline for future comparisons and further support the need for regular functional assessments and the implementation of intervention programs, which could inform health policies and intervention strategies in Chile.

On the other hand, although the study provides valuable insight into the relationship between frailty and functional fitness in older women, there are limitations that future research should consider. For instance, the sampling method (non-probabilistic) and the restricted age range limit the generalizability of the findings; therefore, it is necessary to expand and establish a probabilistic sampling process. This would allow the results to be generalized to other social and cultural contexts.

It should also be noted that the cross-sectional design does not allow for determining whether frailty leads to decreased functional fitness or whether poor functional fitness contributes to frailty. Future studies should consider longitudinal designs that enable the observation of how these variables evolve over time and the assessment of the impact of specific interventions.

5. Conclusions

The study found significant differences in BMI and functional fitness tests between women with and without frailty. Moreover, it was observed that as women age, frailty increases and functional fitness declines, particularly in the sit-to-stand test, biceps curl test, and the 2.44-meter agility test. These assessments may be useful for evaluating fall risk and functional status in women aged 65 to 85 years.

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