Normative values to assess functional fitness in older adults in a region of Chile.

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Abstract

Background

Aging is a global phenomenon that has generated great concerns and challenges in terms of public health and medical care, associated with a lower quality of life.

Objective

To compare the functional fitness of older adults in a region of Chile with other countries, and to propose normative values according to age range and sex.

Methodology:

A descriptive cross-sectional study was carried out in older adults of the central-south region of Chile. The sample selection was non-probabilistic. A total of 787 older adults (180 males and 607 females) with an age range of 60 to 85 years were investigated. Weight and height were assessed. Body mass index (BMI) was calculated. The four physical tests evaluated were: 30-s push-up (reps), 30-s standing chair (rep), 8-ft up-and-go (sec), 2-min step test (rep) and 6-min walk (m). Percentiles were calculated for p10, p25, p50, p75 and p90, through the LMS method (L: Lambda; skewness), M: Mu; median and S: Sigma; coefficient of variation).

Results

Discrepancies in BMI were observed between countries (in males from ~4.3 to 7.0 kg/m² and in females from ~6.7-7.5 kg/m²). In the 30-s push-up test) there were variations from ~3 to 6 repetitions in both sexes. In the 8-ft up-and-go test, discrepancies ranged from ~1.1 to 4.4 seconds. In the aerobic 2-min step test, discrepancies ranged in both sexes from ~21 to 41 repetitions. In the 6-min walk test, the variations between studies ranged from ~150 to 245 meters in both sexes. In the 30-s standing chair test, performance in both sexes was relatively homogeneous, varying from ~1 to 2 repetitions. Percentiles by age range and sex were developed for BMI and the five functional fitness tests.

Conclusion

This study demonstrated that there were discrepancies in BMI and functional fitness performance of older adults between countries in various geographic regions of the world. In addition, the proposed percentiles are an important tool to track individual changes and can be used to evaluate and plan intervention programs in older adults in Chile.

Background

The aging of the world’s population is a global phenomenon that poses significant challenges in terms of public health and medical care. It is considered the main contributor to a wide spectrum of chronic disorders, all of which are associated with a lower quality of life in older adults (OAs) [1].

In general, aging has generated major concerns worldwide, particularly in developing countries, where the increasing number and percentage of OAs has become a pressing issue [2].

In recent years this has generated increasing attention to the assessment and promotion of functional health in this demographic group. Thus, since 1999, when the Senior Fitness test (SFT) was first published for the American population [3], few studies have been interested in developing percentiles to assess functional fitness in OAs from various regions of the world.

For example, in Spain [4], Portugal [5], Poland [6] and China [7–9] reference values have been proposed using SFT tests. However, as far as is known, in Chile there are no reference values to assess functional fitness in OAs of both sexes. Except for some studies that address some physical tests such as aerobic fitness through the 6-minute walk test in adults of both sexes aged 50 to 84 years [10], or the proposed SFT in adult women aged 60 to 85 years [11].

In fact, these studies provide limited data on the assessment of functional fitness in OAs for the Chilean population. Thus, developing a study that encompasses both sexes, a wide age range, and evaluates morphological, muscular, balance, agility, flexibility, and aerobic endurance components would be extremely valuable to better understand the needs of this population and design effective health interventions.

Such a study would not only provide a more complete picture of the functional fitness and wellbeing of OAs in Chile, but would also allow the control of specific interventions tailored to the needs of this population, thus promoting healthy and active aging in the country.
In general, Chile in recent decades has increased life expectancy at birth from 72.6 to 81.2 years in 1990–2023 [12, 13]. At present, the country is experiencing a phase of accelerated aging where the OAs in the country was 3.4% in 1950, reaching 12.2% in 2020, and projected to reach 30% in 2065 [14].

Consequently, Chile is a country with a marked process of nutritional and demographic transition, with marked sociocultural and regional differences [10] (Urzúa-Alul et al, 2019). Therefore, the international reference values that evaluate functional fitness could hardly be adapted to the Chilean population. For functional fitness levels in OAs are the result of dynamic socioeconomic changes, as well as diverse living conditions, sociocultural, ethnic, genetic and geographical aspects [6] (Ignasiak et al, 2018).

Therefore, this study was proposed as an objective, to propose normative values to assess functional fitness in OAs of both sexes from a region of chile and compare with other international studies. Therefore, this study was proposed as an initial objective, to compare the functional fitness of OAs from a region of chile with other countries, and to propose normative values according to age range and sex.

Methodology
Type of study and sample

A descriptive cross-sectional study was carried out in OAs in the central-southern region of Chile. The sample selection was non-probabilistic (accidental). A total of 787 OAs (180 males and 607 females) with an age range of 60 to 85 years were investigated.

All the volunteers belonged to 04 cities (Curicó, Linares, Talca, Chillán) in the central-southern region of Chile. To be eligible, they had to be at least 60 years old and a maximum of 85 years old at the date of the evaluation. In addition, they had to be self-sufficient (walk independently), read and understand the indications of the anthropometric and physical tests to be applied. The OAs who did not complete all the tests and had some visual and hearing impairments that prevented the completion of the tests were excluded.

All volunteers were informed of the objectives of the study and gave informed consent to participate in the research project. The study was conducted in accordance with the indications of the Ethics Committee of the Universidad Católica del Maule (UCM-93/2022), and the guidelines of the Declaration of Helsinki for human subjects.

Techniques and instruments

Data collection was conducted from June 2022 to December 2023. This entire procedure was carried out at the facilities of the OAs clubs. The order of the evaluations was: initially anthropometry (weight and height), followed by the functional fitness tests: 30-s push-up (reps), 30-s standing chair (rep), 8-ft up-and-go (sec), 2-min step test (rep) and 6-min walk (m).

To ensure the reliability of the physical test evaluations, 10% of the studied sample (n = 80 subjects) was evaluated twice. All tests were evaluated with an interval of 7 days between tests. The relative technical error of measurement (TEM%) ranged in the tests from 0.5 to 1.2%.

Anthropometry

Anthropometric measurements were evaluated according to the recommendations of Ross, Marfell-Jones [15]. These measurements were performed by 2 experienced anthropometrists. Body weight (kg) was assessed using a digital scale (SECA, Hamburg) with an accuracy of 0.1 kg. Standing height (cm) was measured using a stadiometer (SECA, Hamburg) with an accuracy of 0.1 cm. Body mass index (BMI) was calculated using the formula [BMI = weight (kg)/height (m)^2].

Functional fitness tests

Five SFT physical tests were applied according to the suggestions described by Rikli, Jones [3]. These tests were:

30-s push-up (reps)

measures arm strength and endurance by counting the number of push-ups performed correctly in 30 seconds. This requires women to repeatedly lift a weight of 2.27 kg (5 lb) and men a weight of 3.63 kg (8 lb) for 30 seconds.

30-s standing chair (rep)

Reflects lower body strength. Requires individuals to stand and sit in a chair for 30 seconds. The number of repetitions is recorded.

8-ft up-and-go (sec)

Assesses agility and dynamic balance. The test is started by sitting in a chair and must travel 2.45m and reach the starting position. Time is recorded in seconds.

2-min step test (rep)
Evaluates aerobic endurance. The maximum number of knee lifts performed in 2 minutes is counted. During the stationary gait, a midpoint between the patella and the anterior superior iliac spine must be produced. The number of repetitions of the right knee is counted.

6-min walk (m)

Its purpose is to assess aerobic endurance by walking in meters. If it is not possible to perform the 6-minute walk test, this test can be substituted by the 2-minute walk test.

For comparison with other studies, research carried out in 5 countries of the world Spain [4], Portugal [5], Poland [6], USA [3] and China (Nanjing-region) [8] and China (Suzhuo-Region) [9] were used.

Statistics

The distribution of the data of the older adults was verified using the Kolmogorov-Smirnov test. The descriptive statistical parameters were then calculated (arithmetic mean, standard deviation, range, confidence interval CI). Significant differences between both sexes were verified by means of the t-test for independent samples. The significance adopted was 0.05. Calculations were performed in Excel spreadsheets and SPSS 16.0. Percentiles (P10, P25, P50, P75, P90) were developed using the LMS method (L: Lambda; skewness, M: Mu; median and S: Sigma; coefficient of variation). Discrepancies between the study and international investigations were compared using the 100 log fraction (reference percentile/calculated percentile).

Results

The anthropometric and physical characteristics of the studied sample are shown in Table 1. There were no significant differences in age and anthropometric profile between both sexes (p > 0.36 to 0.51). In functional fitness, the values were similar; no significant differences were observed between both sexes (p > 0.46 to 0.98).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Anthropometric and physical characteristics of the sample studied.</th>
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<tbody>
<tr>
<td>Variables</td>
<td>Males (n = 180)</td>
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<td>X</td>
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<tr>
<td>Age (years)</td>
<td>71.3</td>
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<tr>
<td>Anthropometry</td>
<td></td>
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<tr>
<td>Weight (kg)</td>
<td>71.2</td>
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<tr>
<td>Height (cm)</td>
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<tr>
<td>BMI (kg/m2)</td>
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<tr>
<td>Functional fitness</td>
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<tr>
<td>30-s push-ups (reps)</td>
<td>20.7</td>
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<tr>
<td>30-s standing chair (rep)</td>
<td>16</td>
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<tr>
<td>8-ft up-and-go (sec)</td>
<td>6.8</td>
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<tr>
<td>2-min step test (rep)</td>
<td>118</td>
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<tr>
<td>6-minute walk (m)</td>
<td>457.2</td>
</tr>
</tbody>
</table>


Table 2 shows the distribution of percentiles (p10, p15, p50, p85 and p90) for both sexes and determined by the LMS method. The BMI and the five tests allow determining the level of functional fitness of older adults in relation to their age group and sex. These categories can help to classify according to performance in each of the tests. Figure 1 shows the BMI percentiles and functional fitness tests. As age advances, BMI and performance on all physical tests decreases.
Table 2
Percentiles distributed in p10, p15, p50, p85 and p90 to assess BMI and functional fitness by age group and sex.

<table>
<thead>
<tr>
<th>Age</th>
<th>Males</th>
<th>Females</th>
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<tbody>
<tr>
<td></td>
<td>n L M S P10 P15 P50 P85 P90</td>
<td>n L M S P10 P15 P50 P85 P90</td>
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<tr>
<td>BMI (kg/m²)</td>
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<tr>
<td>60 to 64</td>
<td>25 -0.1 32.1 0.1 27.5 28.3 32.1 36.5 37.7 93 -0.5 29.2 0.2 24.1 25.0 29.2 34.7 36.2</td>
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<tr>
<td>65 to 69</td>
<td>50 -0.9 29.5 0.1 24.8 25.6 29.5 34.7 36.2 163 -0.2 29.4 0.2 23.8 24.7 29.4 35.1 36.6</td>
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<tr>
<td>70 to 74</td>
<td>45 -1.0 29.2 0.2 24.1 25.0 29.2 35.2 37.0 164 -0.2 29.3 0.2 23.8 24.7 29.3 35.0 36.5</td>
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<tr>
<td>75 to 79</td>
<td>35 -0.4 28.8 0.2 23.5 24.4 28.8 34.4 36.0 123 0.0 29.1 0.2 23.8 24.7 29.1 34.2 35.6</td>
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<td>80 to 85</td>
<td>25 0.5 27.5 0.2 22.2 23.1 27.5 32.3 33.5 64 0.6 28.4 0.1 23.4 24.3 28.4 32.7 33.8</td>
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<tr>
<td>30-s push-up (reps)</td>
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<tr>
<td>60 to 64</td>
<td>25 0.6 20.8 0.3 14.0 15.0 21.0 27.0 29.0 93 0.4 21.6 0.3 14.0 15.0 22.0 29.0 31.0</td>
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<td>65 to 69</td>
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<td>70 to 74</td>
<td>45 0.7 20.1 0.3 12.0 14.0 20.0 27.0 29.0 164 0.7 18.9 0.3 12.0 14.0 19.0 25.0 26.0</td>
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<td>75 to 79</td>
<td>35 0.8 17.9 0.3 11.0 12.0 18.0 24.0 26.0 123 0.8 17.1 0.3 11.0 12.0 17.0 22.0 24.0</td>
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<td>80 to 85</td>
<td>25 1.1 16.4 0.3 10.0 11.0 16.0 22.0 23.0 64 1.1 16.5 0.3 10.0 12.0 17.0 21.0 23.0</td>
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<tr>
<td>8-ft up-and-go (sec)</td>
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<tr>
<td>60 to 64</td>
<td>25 -2.0 5.3 0.2 4.18 4.33 5.26 7.23 8.14 93 -1.4 5.7 0.3 4.36 4.56 5.72 8.01 8.96</td>
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<tr>
<td>65 to 69</td>
<td>50 -1.7 5.4 0.3 4.16 4.34 5.4 7.7 8.77 163 -1.3 6.2 0.3 4.63 4.86 6.16 8.74 9.77</td>
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<tr>
<td>70 to 74</td>
<td>45 -1.5 5.9 0.3 4.45 4.66 5.93 8.68 9.93 164 -1.1 6.7 0.3 4.98 5.24 6.74 9.55 10.62</td>
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<tr>
<td>75 to 79</td>
<td>35 -1.2 7.0 0.3 5.07 5.35 6.98 10.32 11.71 123 -0.9 7.4 0.3 5.34 5.64 7.37 10.42 11.51</td>
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<tr>
<td>80 to 85</td>
<td>25 -0.6 7.8 0.3 5.4 5.76 7.8 11.29 12.49 64 -0.6 8.1 0.3 5.73 6.09 8.06 11.34 12.44</td>
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<td>30-s standing chair (rep)</td>
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<tr>
<td>60 to 64</td>
<td>25 0.0 15.9 0.3 11.0 12.0 16.0 21.0 23.0 93 0.1 16.6 0.3 11.0 12.0 17.0 23.0 25.0</td>
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<td>65 to 69</td>
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<td>80 to 85</td>
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<td>2-min step test (rep)</td>
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<td>80 to 85</td>
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<td>6-min walk (m)</td>
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<tr>
<td>80 to 85</td>
<td>25</td>
<td>0.2</td>
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</tbody>
</table>

Legend: L: Lambda; skewness), M: Mu; median and S: Sigma; coefficient of variation.

Figure 2, shows the comparisons of the components of functional fitness from various countries of the world. These comparisons were made from the 50th percentile and in 5 age ranges (60-64y, 65-69y, 70-74y, 75-79y, 80-85y). For example, in the first component (BMI), Chile and Spain have shown similar BMI values in both sexes and in all age ranges. The study conducted in China (Nanjing-region) by Zhao et al [8], showed the lowest BMI values (in both sexes) in relation to the other countries. The discrepancies observed in p50 in men ranged from ~ 4.3 to 7.0 kg/m² and in women from ~ 6.7-7.5 kg/m².

In the second component (30-s push-up), males in Portugal showed better performance relative to the other countries (~ 4-5 rep). Countries such as China, USA and Chile have shown relatively similar values in all age ranges. Values in this test reflect discrepancies from ~ 4 to 8 repetitions. While, in females, Chilean females showed a better performance in relation to the other countries (~ 2 to 3 repetitions). In general, women from the USA showed lower performance compared to the other countries. Performance variations in this test ranged from ~ 3 to 6 repetitions.

In the third component (8-ft up-and-go), men and women from China (Nanjing-region) [8] and USA [3] have shown better performance in relation to the countries of Portugal, Spain and Chile. However, the OAs (both sexes) from Spain, were the ones that evidenced poor performance in this test (~ < 2 to
In general, discrepancies in agility performance were observed in this test in the five countries compared. In males the variations ranged from ~ 2.2 to 4.4 seconds, and in females it was ~ 1.1 to 3.4 seconds.

In the fourth component (30-s standing chair), the results have shown that it was the only test that evidenced very few discrepancies in both sexes and in all age ranges. Performance in this test is relatively homogeneous, as it varied in males around ~ 1 repetition, while in females ~ 2 repetitions.

In the fifth component (2-min step test), the Chilean OAs (both sexes), showed better performance in this test in relation to the other countries [both studies from China (Nanjing-region [8] and (Suzhuo-Region [9]) and USA [3]. Discrepancies in this test were wider in males (~ 32 to 41 repetitions) than in females (~ 14 to 21 repetitions).

The sixth component (6-min walk), results indicate that there was wide variation in performance on this test. For example, USA OAs (both sexes), evidenced better performance in this test compared to the other countries (Chile, Portugal, Spain and Poland). There were discrepancies in the p50 in the 5 age ranges and in both sexes. In males, distance variations ranged from ~ 155 to 245 meters, while in females they ranged from ~ 150 to 185 meters.

**Discussion**

The results of the study have shown that there were wide discrepancies in the components of functional fitness when compared between the 50th percentile (p50) with other international studies (BMI, 8-ft up-and-go, 2-min step test, 6-min walk). However, the only test that showed similar results between Chilean OAs and other countries was the 30-s standing chair test, where performance was relatively homogeneous in both sexes and in all age ranges, varying slightly in men and women.

We observed discrepancies between studies in BMI, these variations in men ranged from ~ 4.3 to 7.0 kg/m2 and in women from ~ 6.7-7.5kg/m2. In addition, all international studies and the Chilean study have shown a decrease in BMI with increasing age.

This decrease in BMI as age advances is basically due to the loss of muscle mass, bone and other soft tissues, rather than the loss of body fat [4], a product of the aging process.

In fact, the World Health Organization WHO [16] recognizes the natural physical changes that occur in healthy people who age successfully; for example, weight loss, sarcopenia (i.e., muscle deficiency), increase and redistribution of body fat to the abdomen, loss of bone calcium, and consequent decrease in height [16].

These observed changes in BMI in OAs, especially in the reduction of weight status with advancing age, tend to be at increased risk for worse health outcomes and mortality [17]. Consequently, it is expressed in loss of muscle mass, frailty, increased risk of falls, injuries [18] and significant deterioration of general functional fitness [19].

Therefore, it is important to assess and monitor using BMI, as it is considered the most widely used and accepted method to diagnose weight status in the clinical care setting, especially in OAs [20].

In relation to the functional fitness tests, discrepancies were observed in the 30-s push-up test), whose variations for both sexes and age ranges were from ~ 3 to 6 repetitions, similarly in the 8-ft up-and-go test, the discrepancies were for both sexes and ranged from ~ 1.1 to 4.4 seconds. Meanwhile, in the aerobic 2-min test the discrepancies were wider in males (~ 32 to 41 repetitions) than in females (~ 14 to 21 repetitions), and in the 6-min walk test, the results indicate variations from ~ 150 to 245 meters in both sexes. In the 30-s standing chair test, performance in both sexes was relatively homogeneous and across all age ranges, varying slightly in males by one repetition, while in females from ~ 1 to 2 repetitions, respectively.

Overall, these functional fitness tests evaluated in this study clearly reflected discrepancies with international studies [3, 4–6, 8–10]. Since, physical test results may be due to a variety of factors, including geographic variations, lifestyles, medical care, and individual characteristics of OAs [21–23].

We also verified that BMI and physical tests reflect a progressive deterioration with advancing age for both men and women. These findings have previously been described in previous studies [8, 24–26] in which they highlight that it affects men as well as women due to the aging process, which, leads to a series of physical and psychological changes that can affect the functional fitness of OAs [6].

In essence, several studies have shown that various structural and functional changes occur during aging, such as loss of walking ability, muscle strength, balance and flexibility [27, 28]. These changes are often associated with a decrease in functional fitness and ultimately results in impaired functional independence among OAs [29].

Indeed, impaired functional fitness entails a number of physiological and biological changes that can affect a person's ability to perform daily activities independently and efficiently [30].

Consequently, given the discrepancies in functional fitness among OAs from various geographic regions of the world, this study aimed, as a second objective, to propose normative values to assess the functional fitness of OAs from one region of Chile, according to age range and sex.
Normative values on functional fitness in general can allow the assessment of individual performance, which helps to identify functional weaknesses in risk-prone OAs [31].

The development of percentiles is a tool that helps to identify OAs, whose fitness level is below normal for their age and sex and below the recommended standards for independent functioning [5], or even, can identify those who are above average or better functional performers [3].

In general, this study was based on cut-off points that have been adopted by previous studies [3, 6, 8]. For example, p10, p25, p50 and p75, p90, whose categorizations are interpreted as low, normal and high performance (< p25, p50 and > p75). Although, recently a study conducted on OAs living in rural areas of southern Taiwan has suggested the < p30, p50 and > p70 percentiles [32].

In fact, due to social, cultural and racial differences the use and generalization of normative data among various countries and geographic regions is not effective [33]. Therefore, differences in the assessment of functional fitness among OAs may be the result of a complex interaction between individual, social, environmental and health factors [34–36]. Thus, these differences need to be taken into account when applying and interpreting normative data in different geographical contexts.

In that context, the normative values proposed here are a valuable and fundamental tool for the regional population of Chile, and can be used to track individual changes, can facilitate the understanding of the fitness status of OAs. It can also be used to monitor intervention programs and develop public policies.

This study has some strengths and weaknesses, which are described below. For example, it is one of the first studies carried out in Chile in OAs of both sexes and shows comparisons with other regions of the world. The percentiles proposed here can help to better understand the health status and functional fitness of this regional population, as well as can serve in the design and control of physical exercise and rehabilitation programs adapted to the needs of the OAs and in the field of research, the percentiles developed can serve as a baseline for future comparisons of secular trend.

**Conclusions**

However, some weaknesses are also observed, these have to do with the selection of the non-probabilistic sample, since it is not possible to generalize the results to an entire country, limiting them to the central-southern region of Chile. The cross-sectional design used limits the cause and effect relationships, which makes it necessary for future studies to develop longitudinal research to establish and explain the causal relationships. Also, it is necessary to control some environmental and sociodemographic variables, which have to do with access to medical care, socioeconomic status, and lifestyles.

**Abbreviations**

BMI
Body mass index
OAs
older adults
SFT
the Senior Fitness test
TEM
technical error of measurement

**Declarations**

**Acknowledgements**

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**Availability of data and materials**

The datasets supporting the conclusions of this research article are available by emailing the corresponding author.

**Authors’ contributions**

M.C.B., R.G.C., and R.V.E. contributed to the design of the research study. R.V.E, L.F.C, C.U.A., A.G., L.U.A., and C.L.R. collected data. M.C.B., R.G.C., M.S.R., and J.S.T. contributed to the discussion, wrote the manuscript and reviewed/edited the manuscript. M.C.B. and R.G.C edited and reviewed the manuscript. All authors revised and agreed on the views expressed in the manuscript.

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Ethics approval and consent to participate

The study protocol was approved by the Ethics Committee of the Universidad Católica del Maule, 93-2022. All evaluations were performed in accordance with relevant guidelines and regulations (such as the Declaration of Helsinki). In addition, all participants gave written informed consent.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

References

5. Marques et al, 2014


31. Chung et al 2019


**Figures**
Figure 1

BMI percentiles and functional fitness tests by age group and sex.
Figure 2

Comparison of BMI and functional fitness of OAs from the study versus international studies (Chile: Present study, Spain [4], Portugal [5], Poland [6], China (Nanjing-Region) [8] and China (Suzhuo-Region) [9] and USA [3].