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Normative functional fitness standards and trends of Portuguese older adults: Cross cultural comparisons

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Abstract

This cross-sectional study was designed to develop normative functional fitness standards for the Portuguese older adults, to analyze age and gender patterns of decline, to compare the fitness level of Portuguese older adults with that of older adults in other countries, and to evaluate the fitness level of Portuguese older adults relative to recently published criterion fitness standards associated with maintaining physical independence.

4712 independent-living older adults, age 65-103 yr, were evaluated using the Senior Fitness Test battery.

Age-group normative fitness scores are reported for the 10th, 25th, 50th, 75th, and 90th percentiles. Results indicate that both women and men experience age-related losses in all components of functional fitness, with their rate of decline being greater than that observed in other populations, a trend which may cause Portuguese older adults to be at greater risk for loss of independence in later years. These newly established normative standards make it possible to assess individual fitness level and provide a basis for implementing population-wide health strategies to counteract early loss of independence.

Keywords: elderly, physical performance, exercise testing, normative data

Introduction

Adults over the age of 65 reflect the fastest growing segment of the population in most industrialized countries, including Portugal. The percentages of elderly (65+) Portuguese adults has increased from 13% in 1994 to 19% in 2011 (<http://www.ine.pt>), and is projected to further increase to 33% by 2050 (Hooyman & Kiyak, 2011). Besides the increased health care costs associated with this increase in older adults, Portugal, along with Spain and Italy, is also expected to have the highest older age dependency ratios compared to the other EU member states (Muenz, 2007). The increasing longevity of modern populations explains much of the alarming increase in the number of older adults with functional limitations. Consequently, health-related physical/functional fitness, as it pertains to disease prevention and health promotion (Topp, Fahlman, & Boardley, 2004), is extremely relevant in the promotion of healthy aging and control of health care costs.

Functional fitness has been defined as the physiologic capacity to perform normal everyday activities safely, independently, and without undue fatigue (Rikli & Jones, 1999a). The major components of functional fitness are lower and upper body strength, lower and upper body flexibility, aerobic fitness, and motor agility/dynamic balance. Basic components of strength, balance, coordination, flexibility, and aerobic fitness are the necessary building blocks that allow performance of those activities required for independent living such as doing simple household chores, walking, climbing steps, and carrying objects, activities that will support functional independence and quality of life into older age (Rikli & Jones, 1999a). Deficits in the major components of functional fitness are linked not only to physical disability (Maslow et al., 2011), including increased risk of falls and fractures (Lopez-Caudana et al., 2004; Rizzoli et al., 2009), but also to cognitive decline (Auyeung, Lee, Kwok, & Woo, 2011; Erickson et al., 2012) and reduced quality of life (Olivares, Gusi, Prieto, & Hernandez-Mocholi, 2011). Thus, identifying elders whose fitness level is below that which is normal for their age and gender and below the recommended

standards of fitness needed for independent functioning should be considered a relevant preventive health strategy.

Therefore, in an attempt to better understand the relative fitness level of Portuguese older adults and their possible risk for loss of physical independence, the purposes of this study were to: 1) develop normative functional fitness standards (including body mass index (BMI) and waist circumference) for the Portuguese older adults; 2) analyze and describe age and gender patterns of decline for Portuguese older adults; 3) compare the fitness level of Portuguese older adults to the normative standards of older adults in other countries, and 4) evaluate the fitness level of Portuguese older adults relative to recently published criterion fitness standards associated with maintaining physical independence. The following sections will be presented and discussed under each of the four purposes (phases) of the study as appropriate.

Methods

Subjects

Data for the present study were derived from a cross-sectional representative sample of the community-residing Portuguese population aged 65 and up, which included five sampling areas covering the entire mainland of Portugal. Thus, 4712 Caucasian volunteers (3121 women, 1591 men) with an age range of 65–103 years were evaluated. Study participants were volunteers solicited from community senior (social) centers, public and private institutions, sport clubs, and social/sport events. All the participants had independent physical function. The study was carried out in full compliance with the Helsinki Declaration and approved by the University ethics committee. All subjects read and signed the consent form before the testing procedures. Sample characteristics are presented in Table 1.

Testing procedures

Data were collected between January 2008 and April 2009 by a group of specialized evaluators, previously trained to minimize inter-observer variation.

Prior to testing, participants completed a questionnaire assessing basic demographic information with the aide of a technician whenever needed to help respondents understand and answer a question. Current levels of physical activity or sport activity were measured by the response to the question “Do you practice sports or physical activity sufficient to produce sweating or shortness of breath?” Possible responses were yes or no, and the type of activities and frequency of practice (days per week) were also asked. All functional fitness and anthropometric testing was completed in a single day using a circuit style format, with participants first completing an 8 to 10-minute warm-up lead by a physical education instructor.

Functional fitness measures

Functional fitness was assessed using the Senior Fitness Test (SFT) battery, which consisted of six items, designed and validated to assess the physiological parameters that support physical mobility in older adults by Rikli and Jones (1999a, 2013).

Lower body strength was measured using the 30 s chair stand test. Participants were asked to sit in a 43-cm high chair with arms crossed at the wrists and held against the chest. Participants completed as many stands as possible within 30 s. The score was the total number of stands executed correctly within 30 s. *Upper body strength* was assessed using the arm curl test. Participants performed as many biceps curls as possible in 30 s, using a dumbbell (2.27 kg (5 lb) and 3.63 kg (8 lb) for women and men, respectively). The score was the total number of hand-weight curls performed through the full range of motion in 30 s. *Lower body flexibility* was assessed using the chair sit-and-reach test. The score was the best distance achieved between the extended fingers and the tip of the toe, measured to the nearest 0.5 cm. *Upper body flexibility* was assessed using the back scratch test. The score was the shortest distance achieved between the extended middle fingers, measured to the nearest 0.5 cm. *Agility and dynamic balance* was assessed using the 8-foot (8 ft) up and go test. The score was the shortest time to rise from a seated position, walk 2.44m (8 ft), turn, and return to the seated position, measured to the nearest 1/10th s. *Aerobic endurance* was

measured using the 6-min walk test. Participants were asked to walk as fast as possible for 6 minutes with verbal encouragement given in 30 s intervals. The score was the total distance walked in 6 min along a 45.72 m rectangular course, which was marked every 4.57 m. Test-retest reliabilities of the SFT battery are between 0.80 (arm curl) and 0.90-0.96 (for the other tests) (Rikli & Jones, 2013). Each test protocol involved a demonstration by the test administrator and an opportunity to practice the item to show correct form. Participant scores for the 30 s chair stand, 30 s arm curl, and 6-minute walk were based on only one test trail, whereas two test trials were given for the chair sit and reach, back scratch, and 8-ft up-and-go, with the best score counted. Full detailed information on test administration and protocols can be found at Rikli and Jones (2013).

Anthropometric measures

Body weight (to the nearest 0.1 kg) and height (to the nearest 0.1 cm) were measured using a portable stadiometer and balance weighing scales, respectively, while subjects were dressed in light clothing and stood barefoot, erect with eyes directed straight ahead. BMI was calculated using the standard formula, and was categorized into six groups (underweight, $< 18.5 \text{ kg/m}^2$; normal, 18.5 to 24.99 kg/m^2 ; overweight, 25.00 to 29.9 kg/m^2 ; obese class I, 30 to 34.99 kg/m^2 ; obese II, 35.00 to 39.9 kg/m^2 ; obese III, $\geq 40 \text{ kg/m}^2$), according to World Health Organization (WHO) criteria (2000).

Waist circumference was measured using a heavy-duty inelastic tape, which was kept in contact with the skin without pressing it. Waist circumference was measured in a horizontal plane immediately above the level of the suprailiac (just lateral and above the iliac crest) in the midaxillary line, according to the National Institute of Health (2000) protocol. The measurement was made at the end of a normal expiration. Abdominal obesity was defined as waist circumference $\geq 102 \text{ cm}$ in men and $\geq 88 \text{ cm}$ in women, based on criteria from the NCEP ATP III (2002).

Statistical analyses

All statistical analyses were performed using IBM SPSS[®] Statistics (version 20) for Windows (SPSS Inc., an IBM Company, Chicago IL, USA) using a significance level of 0.05 (2-tailed). The data

are presented stratified by age, reported as mean and standard deviation (SD) for continuous variables and as frequencies and percentages for categorical variables.

The Kolmogorov-Smirnov statistic was used to test the normalcy within each age group. The 10th, 25th, 50th, 75th and 90th percentiles were chosen as the normative reference points for each five-year age group (65-69, 70-74, 75-79, 80-84, and >85). Smoothed percentile curves (see Figures 1 and 2) were estimated using Cole’s LMS method (Cole & Green, 1992).

With the purpose of analyzing age and gender differences within the Portuguese population, between-group comparisons of continuous variables were performed using *t*-tests, except for a few cases where required conditions were not satisfied, and Wilcoxon test was used as a nonparametric alternative. Chi-square tests were used for between-group comparisons of categorical variables or for differences in proportions. A two-way ANOVA was used to test for main effects and interaction effects across gender and age groups (65-69, 70-74, 75-79, 80-84, and ≥85 years). Bonferroni post-hoc tests were then used when warranted. The meaningfulness of the outcomes was estimated through the effect size (ES), using the following calculation: $ES = (M_1 - M_2) / S_p$, where M_1 = the mean of group 1 variable values, M_2 = the mean of group 2 variable value, and S_p = pooled standard deviation, according the following equation:

$$S_p = \sqrt{\frac{s_1^2(n_1 - 1) + s_2^2(n_2 - 1)}{n_1 + n_2 - 2}}$$

where S_1^2 = the variance of group 1, S_2^2 = the variance of group 2, n_1 = the number of participants in group 1, and n_2 = the number of participants in group 2. An $ES \leq 0.2$ is considered small, an ES between 0.3 to 0.7 is moderate, and an $ES \geq 0.8$ is large (Thomas, Nelson, & Silverman, 2005).

In order to compare fitness levels of Portuguese older adults with older adults from other countries, mean scores from this study were compared with previous study results from the United

States, Brazil, Taiwan, and Spain where data were available on the same age groups using the same testing protocols.

Finally, to evaluate the fitness level of Portuguese older adults relative to that which may be needed to remain physically independent throughout their lifespan, scores were compared to criterion-reference fitness standards that were recently developed in the United States

(Rikli & Jones, 2012). Criterion standards, it should be pointed out, are different from normative standards. Whereas normative standards provide information on what is ‘normal’ for a given population, criterion standards provide information on what is desirable to reach a certain goal, such as remaining independent. Data were analyzed to determine the proportion of Portuguese older adults within each five-year age group who were classified as having met the criterion fitness standard on each of the fitness categories.

Results and Discussion

Demographics

Characteristics of the sample are presented in Table 1. Men were significantly taller and heavier than women, thus their BMI was lower than women. Waist circumference was greater in men than in women (98.3 ± 10.7 vs. 94.3 ± 11.8 cm; $p < 0.001$). Using WHO classic definitions based on BMI values, the greater part of men and women fall into the overweight category (48.2 and 44.1%, respectively). The prevalence of normal-weight and overweight categories was significantly higher for men, while women are proportionally more obese (I, II, and III classes) than men. Moreover, abdominal obesity was significantly more prevalent in women (69.1%) compared to men (33.9%).

Functional fitness normative standards development

Tables 2 and 3 show the 10th-, 25th-, 50th-, 75th-, and 90th-percentile score on each test for women and men, respectively by age group representing the values below which a certain

percentage of observations fall. For BMI and waist circumference both tables present the age- and sex-specific percentile values.

Sex- and age-specific smoothed percentile curves for each test of functional fitness are shown in Figure 1. The shape of 8 ft up and go curves at the age groups 80-84 years and 85+ years was slightly dissimilar. In women, the percentile values tended to decrease, whereas, in men, the percentile curve tended to be flat.

Figures 2 presents the sex- and age-specific smoothed BMI and waist circumference percentile curves. The shape of BMI and waist circumference curves was similar in both sexes.

The present normative fitness standards should be used to reveal the individual's status relative to the normative 65 and older Portuguese population, and are instrumental for national future trends analysis and international comparisons. For instance, by comparing their own scores to the percentile tables, Portuguese older adults can perceive if their fitness level fall in the top or bottom 10% or 25% of the population. Additionally, this information is valuable for educating and motivating behavioral change, for planning and evaluating exercise interventions targeting individual areas of weakness.

Analysis of age and gender differences within the Portuguese population

Table 4 provides means and standard deviations for each test item, along with ANOVA p values for main effects of age and gender and for age and gender interaction effects. As indicated in Table 4, gender main effects are significant on all test items ($p < 0.001$), with men generally performing better than women on the chair stand, arm curl, 6-minute walk, and 8-ft up-and go test, but with women performing better than men on the two flexibility items, the chair sit-and-reach and back scratch. Although the differences between men and women did not reach significance in every 5-year age group, these same trends for test-specific gender superiority was evident throughout all ages, results which are similar to those reported elsewhere. Age main effects are also significant on all test items, showing a progressive reduction from the youngest to oldest age groups ($p < 0.001$).

Similar to previous studies (Gusi et al., 2012; Krause et al., 2009; Rikli & Jones, 1999b) a statistical significance was not always reached between age groups. Mean differences between successive age groups (65-69 vs. 70-74 years; 70-74 vs. 75-79 years; 75-79 vs. 80-84 years; and 80-84 vs. ≥ 85 years) and respective standard deviations were used to calculate the effect size. Despite the significance of several differences, the magnitude of the effect size for all tests was small (0.0 – 0.4).

Interactions were observed for 30 s chair stand, chair sit-and-reach, and 8 ft up and go tests ($p < 0.001$). Accordingly, for these variables a different response in each group was evident over time. The lack of significant age by gender interaction in the remaining test items indicates a similar pattern of decline across ages for males and females.

A slightly lower BMI was observed in women, between the age group ≥ 85 and the two lower age groups (65-69 and 70-74 years). These results were not unexpected and agree with a number of studies (Chen, Lin, & Yu, 2009; Gusi et al., 2012; Krause et al., 2009; Rikli & Jones, 1999b). In brief, aging is associated with progressive structural, functional, and metabolic alterations in a variety of tissues and systems that are believed to partially explain the observed changes in functional fitness parameters (Chodzko-Zajko et al., 2009). Moreover, no significant differences in BMI between men and women with 85 years and more were observed. On the other hand, a higher waist circumference was observed till the 80-84 age group (being significantly different than mean values of the two first age groups only in women), and lower values at the old age group (≥ 85 years). Men for all age groups had significantly larger waist circumference measures than women. Although profound changes in body composition occur with aging, such as loss of bone mass, muscle mass, and increase of fat mass (St-Onge & Gallagher, 2010), both BMI and waist circumference do not unambiguously translate the progressive increase in the ratio between fat and lean body mass that accompanies aging (Prentice & Jebb, 2001). Probably the decrease observed in BMI in old age may indicate a loss of muscle mass and bone, rather than a loss of fat mass.

Comparison of fitness level of Portuguese older adults with older adults in other populations

An important finding from our research is that Portuguese older adults decline at a faster rate on all variables than those from other countries (Table 5), even on the two strength tests where Portuguese scores were comparatively higher (namely in the youngest age groups). What might account for this faster rate of decline is the fact that fewer Portuguese older adults engage in moderate level physical activity/exercise (15.1% reported exercise practice of at least 3 days per week) compared to other populations where the rate of participation in moderate exercise is higher, such as in the United States where up to 65% of older adults self-reported that they engaged in moderate exercise three times a week (Rikli & Jones, 1999b).

Spanish and Portuguese older adults, revealed more compatible fitness-performance results in the 6-min walk test, though Portuguese older adults scored better particularly at the age group 65 to 74 years. Interestingly, the 8 ft up and go test was associated with the largest decline (49.6% for women and 42.7% for men), which was clearly greater than in Brazil and US older adults. Similar to US results, in the current study the arm curl test had the lowest decline for both women (29.9%) and men (23.2%). Previous cross-sectional studies that examined age-related changes in strength, showed declines as great as 30–35% (Vandervoort, 2002), while longitudinal studies reported changes in knee extensor and flexor of 14-16% per decade, respectively (Kanis et al., 2002), which are somewhat consistent with our results. The percent of decline that we observed in chair-stand performance over more than 2 decades was 31.1% for men and 35.5% for women. When considering the same period, Rikli and Jones (1999b) reported a 18.4% and 16.3% of decline on lower body strength for men and women, respectively. Moreover, the slower rates of decline observed on the arm-curl performance in Portuguese older adults are consistent with slightly slower rate of decline in the upper body strength compared to lower body strength (Hughes et al., 2001; Rikli & Jones, 1999b, 2012).

A decline in maximal aerobic capacity experienced with aging is, together with skeletal muscle performance, a key example of physiological aging (Chodzko-Zajko et al., 2009). The finding that the decline in 6-min walk test performance averaged 35.7% in men and 37.6% in women over 2 decades is quite higher compared with the averaged decline observed in the other countries. In fact, clinicians and health-related professionals in Portugal should pay particular attention to these findings given that maximal aerobic fitness is an important independent predictor of death in older adults (Sui, Laditka, Hardin, & Blair, 2007).

Evaluation of the fitness level of Portuguese older adults relative to recently published criterion-referenced fitness standards for maintaining physical independence in later years

The percentages of participants categorized as meeting the recommended fitness standards associated with independent functioning developed by Rikli and Jones (2012) for 4 test items across 5 age groups for both men and women are presented in Table 6. The proposed criterion-referenced standards (and the fitness test battery) provide a unique approach for evaluating physical capacity in older adults relative to that associated with maintaining physical independence until late in life. These standards were developed based on recent research in the United States which identified the fitness level needed at each 5-year age interval to remain physically independent until age 90+, despite usual age-related declines (Rikli & Jones, 2012). As seen in Table 6, the proportion of those Portuguese older adults considered as having met the fitness standards tended to decrease with age, which again stresses a faster than normal decline in later years that may be putting the older adult population at increased risk for loss of independence. As also seen in Table 6, a higher percentage of Portuguese men tended to have met the fitness standards better than women, which is consistent with data reported elsewhere (Rikli & Jones, 2012; Webber, Porter, & Menec, 2010; West et al., 1997), thus, suggesting that Portuguese older women appear to be more prone “at risk” for premature loss of physical independence than older adult men. Based on the present

results, there appears to be a need for increased attention to fitness levels of older Portuguese adults, especially in the later years and especially in women.

Study strengths and limitations

An important strength of this study is that the reported normative fitness standards are based on a relatively large ($n = 4,712$) comprehensive sample of Portuguese older adults (over 65 population). Another strength of this study is its uniqueness in providing a comparison of normative fitness scores of older adults across several different countries. Further, it appears to be the first study to compare older adult fitness scores standards from another country to the criterion-referenced standards developed in the United States.

A major limitation of this study is that normative scores were established based on unequal samples sizes for some test items, such as on the 6-min walk test where there were fewer participants than on other test items.

Conclusion

The present normative fitness standards provide a previously unavailable means of evaluating the fitness level of Portuguese older adults relative to their own age and gender peers. Moreover, a comparison of these results with those of other populations should be used to reveal the individual's status relative to the normative 65 and older Portuguese population, and are instrumental for national future trends analysis and international comparisons. The present work demonstrated that Portuguese older adults decline at a faster rate on all variables than those from other countries. This information should be valuable for educating the Portuguese citizenry, for motivating behavioral change, and for planning and evaluating exercise interventions that target individual areas of weakness.

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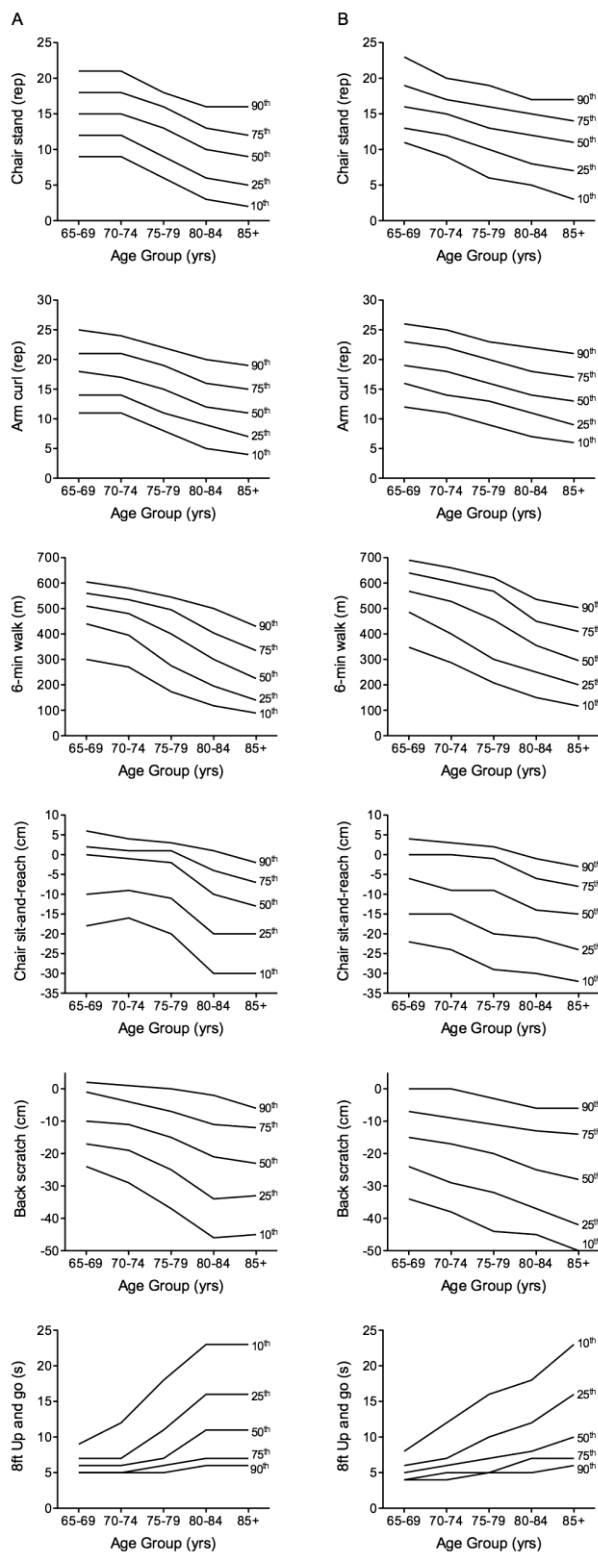


Figure 1.

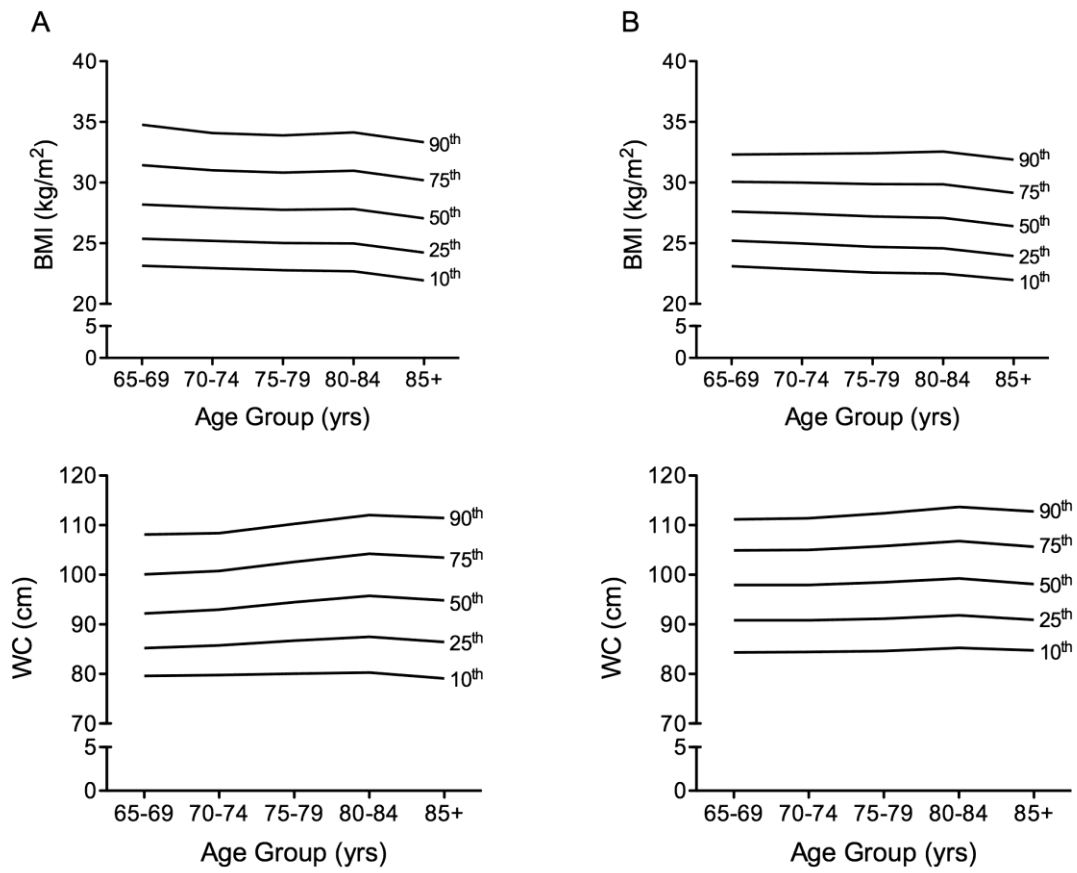


Figure 2.

Table 1 Participant characteristics, mean (SD)

Variable	All (n=4712)	Women (n=3121)	Men (n=1591)
Age, years	75.0 (7.2)	74.8 (7.1)	75.3 (7.4)
Body mass index, kg m ⁻²	28.0 (4.3)	28.2 (4.5)	27.4 (3.8)*
Obesity classification, %			
underweight	0.9	1.0	0.8
normal range	24.8	23.4	27.5*
overweight	45.5	44.1	48.2*
obese class I	23.0	24.2	20.6*
obese class II	4.8	5.8	2.8*
obese class III	1.0	1.5	0.1*
Waist circumference, cm	95.6 (11.6)	94.3 (11.8)	98.3 (10.7)*
Abdominal obesity, %	57.3	69.1	33.9*
Moderate exercise practice (≥3d/w), %	15.1	13.9	17.4*

d/w =days/week * Significant differences between genders (p < 0.05); SD; standard deviation

Table 2 Age-group percentile norms for women

	n	Percentile				
		10 th	25 th	50 th	75 th	90 th
30s chair stand, reps						
65-69	838	9	12	15	18	21
70-74	793	9	12	15	18	21
75-79	589	6	9	13	16	18
80-84	419	3	6	10	13	16
≥85	351	2	5	9	12	16
Arm curl, reps						
65-69	839	11	14	18	21	25
70-74	797	11	14	17	21	24
75-79	594	8	11	15	19	22
80-84	431	5	9	12	16	20
≥85	358	4	7	11	15	19
6-min walk, m						
65-69	627	300	440	510	560	605
70-74	617	270	395	480	535	580
75-79	435	173	275	400	495	545
80-84	296	118	195	300	404	500
≥85	247	89	140	225	335	430
Chair sit-and-reach, cm						
65-69	842	-18.0	-10.0	0.0	2.0	6.0
70-74	803	-16.0	-9.0	-1.0	1.0	4.0
75-79	594	-20.0	-11.0	-2.0	1.0	3.0
80-84	426	-30.0	-20.0	-10.0	-4.0	1.2
≥85	354	-30.0	-20.0	-13.0	-7.0	-2.3
Back scratch, cm						
65-69	838	-24.1	-17.0	-10.0	-1.0	2.0
70-74	792	-29.0	-19.0	-11.0	-4.0	1.0
75-79	586	-37.0	-25.0	-15.3	-7.0	0.4
80-84	423	-45.6	-34.0	-21.0	-11.0	-2.0
≥85	349	-45.0	-33.0	-23.0	-12.0	-6.0
8ft up and go, s						
65-69	788	9.1	6.8	5.6	5.0	4.5
70-74	743	11.6	7.2	6.0	5.2	4.7
75-79	572	18.3	11.2	7.3	5.9	5.1
80-84	401	23.4	16.3	10.6	7.1	6.0
≥85	339	29.0	20.0	12.6	8.5	6.4
Body mass index, kg/m²						
65-69	811	23.1	25.4	28.2	31.4	34.8
70-74	772	23.0	25.2	27.9	31.0	34.1
75-79	586	22.8	25.0	27.8	30.8	33.9
80-84	417	22.7	25.0	27.8	31.0	34.1
≥85	356	21.9	24.2	27.0	30.2	33.3
Waist circumference, cm						
65-69	714	79.6	85.2	92.2	100.1	108.1
70-74	680	79.8	85.8	93.0	100.8	108.4
75-79	482	80.1	86.7	94.5	102.6	110.2
80-84	352	80.3	87.5	95.8	104.2	112.0
≥85	305	79.1	86.5	94.9	103.5	111.4

reps; repetitions

Table 3 Age-group percentile norms for men

	n	Percentile				
		10 th	25 th	50 th	75 th	90 th
30s Chair stand, reps						
65-69	416	11	13	16	19	23
70-74	367	9	12	15	17	20
75-79	280	6	10	13	16	19
80-84	238	5	8	12	15	17
≥85	204	3	7	11	14	17
Arm curl, reps						
65-69	413	12	16	19	23	26
70-74	371	11	14	18	22	25
75-79	289	9	13	16	20	23
80-84	247	7	11	14	18	22
≥85	207	6	9	13	17	21
6-min walk, m						
65-69	284	348	489	568	640	690
70-74	246	287	400	528	605	660
75-79	177	208	300	455	568	621
80-84	143	150	250	355	450	536
≥85	111	117	200	295	410	504
Chair sit-and-reach, cm						
65-69	416	-22.0	-15.0	-6.0	0.0	3.5
70-74	375	-24.0	-15.0	-8.5	0.0	2.7
75-79	290	-28.9	-20.0	-9.0	-1.0	1.9
80-84	249	-30.0	-21.0	-14.0	-5.5	-1.0
≥85	205	-32.4	-23.5	-15.0	-8.0	-2.6
Back scratch, cm						
65-69	412	-34.0	-24.4	-15.0	-7.0	0.0
70-74	366	-38.0	-29.0	-17.0	-9.0	0.0
75-79	283	-43.6	-32.0	-20.0	-11.0	-3.0
80-84	238	-45.0	-37.0	-25.0	-13.0	-6.0
≥85	204	-50.0	-42.0	-28.0	-14.0	-6.2
8ft up and go, s						
65-69	398	7.8	6.1	5.1	4.4	4.0
70-74	355	12.3	7.5	5.9	5.0	4.3
75-79	278	16.4	9.9	6.9	5.4	4.9
80-84	239	18.0	12.0	8.3	6.8	5.5
≥85	206	22.8	16.0	10.1	7.4	5.9
Body mass index, kg/m²						
65-69	409	23.1	25.2	27.6	30.1	32.3
70-74	368	22.9	25.0	27.4	30.0	32.4
75-79	286	22.6	24.7	27.2	29.9	32.4
80-84	246	22.5	24.6	27.1	29.9	32.6
≥85	205	22.0	24.0	26.4	29.2	31.9
Waist circumference, cm						
65-69	337	84.3	90.8	97.9	104.9	111.2
70-74	312	84.5	90.8	97.9	105.0	111.4
75-79	249	84.6	91.2	98.5	105.8	112.4
80-84	205	85.3	91.8	99.3	106.8	113.7
≥85	169	84.8	90.9	98.1	105.6	112.8

reps; repetitions

Table 4 Functional fitness test scores according to age and gender, mean (SD)

	All	Age group*					ANOVA	
		65-69	70-74	75-79	80-84	≥85	p (age)	p (interaction)
30s chair stand, reps								
Women	13.1 (5.5)	15.2 (4.9)	14.9 (4.9)	12.5 (4.9) ^{a,b}	9.8 (5.0) ^{a,b,c}	8.6 (5.2) ^{a,b,c,d}	<0.001	<0.001
Men	13.8 (5.5)	16.4 (5.1)	14.8 (4.7) ^a	12.9 (5.1) ^{a,b}	11.3 (5.0) ^{a,b,c}	10.5 (5.4) ^{a,b,c}	<0.001	
p (gender)	<0.001	<0.001	0.668	0.223	<0.001	<0.001		
Arm curl, reps								
Women	15.6 (6.0)	17.7 (5.5)	17.3 (5.4)	15.1 (5.6) ^{a,b}	12.4 (5.6) ^{a,b,c}	11.4 (5.9) ^{a,b,c}	<0.001	0.092
Men	16.7 (6.1)	19.0 (5.6)	18.2 (5.6)	16.0 (5.3) ^{a,b}	14.6 (6.0) ^{a,b,c}	13.3 (6.2) ^{a,b,c}	<0.001	
p (gender)	<0.001	<0.001	0.018	0.020	<0.001	<0.001		
6-min walk, m								
Women	404.7 (151.3)	486.7 (114.7)	453.9 (119.8) ^a	378.4 (140.6) ^{a,b}	303.7 (137.1) ^{a,b,c}	240.8 (126.5) ^{a,b,c,d}	<0.001	0.862
Men	455.4 (168.4)	544.2 (140.4)	499.5 (144.2) ^a	433.3 (162.3) ^{a,b}	350.2 (139.0) ^{a,b,c}	301.4 (139.9) ^{a,b,c,d}	<0.001	
p (gender)	<0.001	<0.001	<0.001	<0.001	0.001	<0.001		
Chair sit-and-reach, cm								
Women	-7.1 (11.0)	-4.1 (9.7)	-4.3 (9.2)	-6.1 (10.0) ^{a,b}	-13.1 (12.4) ^{a,b,c}	-14.9 (10.5) ^{a,b,c}	<0.001	<0.001
Men	-15.6 (14.0)	-7.7 (10.2)	-9.3 (10.4)	-11.3 (11.5) ^a	-14.3 (11.1) ^{a,b,c}	-16.4 (11.8) ^{a,b,c}	<0.001	
p (gender)	<0.001	<0.001	<0.001	<0.001	0.161	0.090		
Back scratch, cm								
Women	-15.6 (14.0)	-10.6 (11.0)	-12.5 (11.9) ^a	-17.2 (14.2) ^{a,b}	-22.7 (15.3) ^{a,b,c}	-23.8 (15.0) ^{a,b,c}	<0.001	0.151
Men	-20.9 (15.0)	-15.8 (13.0)	-18.7 (13.7) ^a	-22.1 (15.1) ^{a,b}	-25.3 (14.6) ^{a,b}	-28.5 (16.6) ^{a,b,c}	<0.001	
p (gender)	<0.001	<0.001	<0.001	<0.001	0.015	<0.001		
8ft up and go, s								
Women	9.6 (7.8)	6.8 (4.0)	7.4 (4.9) ^a	9.8 (6.6) ^{a,b}	13.6 (10.9) ^{a,b,c}	15.8 (10.9) ^{a,b,c,d}	<0.001	<0.001
Men	8.5 (6.0)	5.9 (2.9)	7.4 (5.0) ^a	9.0 (6.7) ^{a,b}	10.3 (5.8) ^{a,b}	12.8 (7.9) ^{a,b,c,d}	<0.001	
p (gender)	<0.001	0.024	0.943	0.125	<0.001	<0.001		
Body mass index, kg/m²								
Women	28.2 (4.5)	28.7 (4.8)	28.3 (4.3)	28.1 (4.4)	28.2 (4.6)	27.4 (4.5) ^{a,b}	<0.001	0.925
Men	27.4 (3.8)	27.7 (3.6)	27.6 (3.6)	27.4 (4.0)	27.4 (4.0)	26.7 (3.9)	0.123	
p (gender)	<0.001	<0.001	0.007	0.020	0.014	0.073		
Waist circumference, cm								
Women	94.3 (11.8)	93.3 (11.7)	93.6 (10.7)	94.9 (12.2)	96.0 (12.5) ^{a,b}	95.1 (12.5)	0.001	0.801
Men	98.3 (10.7)	97.8 (10.6)	98.0 (10.2)	98.4 (11.1)	99.4 (11.3)	98.5 (10.8)	0.597	
p (gender)	<0.001	<0.001	<0.001	<0.001	0.001	0.002		

*Sample sizes for each group are presented in Table 3. reps repetitions, SD standard deviation.

^a significantly different from 65-69 group, p < .05; ^b significantly different from 70-74 group, p < .05; ^c significantly different from 75-79 group, p < .05; ^d significantly different from 80-84 group, p < .05.

Table 5 Cross-cultural comparisons of functional fitness mean scores on four Senior Fitness Test items

	Age groups				% of decline
	65-69	70-74	75-79	80-84	
30 s chair stand, reps					
U.S. Women	13.5	12.9	12.5	11.3	16.3
Brazilian Women	12.9	12.6	12.2	10.7	17.1
Taiwanese Women	14.0	12.0	12.0	10.0	28.6
Portuguese Women	15.2	14.9	12.5	9.8	35.5
U.S. Men	15.2	14.5	14.0	12.4	18.4
Taiwanese Men	15.8	14.4	13.3	11.4	27.8
Portuguese Men	16.4	14.8	12.9	11.3	31.1
30 s arm curl, reps					
U.S. Women	15.2	14.5	14.0	13.0	14.5
Brazilian Women	14.6	13.8	13.0	12.0	17.8
Portuguese Women	17.7	17.3	15.1	12.4	29.9
U.S. Men	18.4	17.4	16.2	16.0	13.0
Portuguese Men	19.0	18.2	16.0	14.6	23.2
6-min walk, m					
U.S. Women	519	501	465	422	18.7
Brazilian Women	487	478	451	391	19.7
Spanish Women	414	386	360	319	22.9
Portuguese Women	487	454	378	304	37.6
U.S. Men	577	560	507	479	17.0
Spanish Men	430	408	386	345	19.8
Portuguese Men	544	500	433	350	35.7
8ft up and go, s^a					
U.S. Women	5.6	6.0	6.3	7.2	22.2
Brazilian Women	6.2	6.5	7.0	8.4	26.2
Portuguese Women	6.8	7.4	9.8	13.5	49.6
U.S. Men	5.1	5.3	5.9	6.4	20.3
Portuguese Men	5.9	7.4	9.0	10.3	42.7

^a The percent of change in performance for the 8ft up-and-go was calculated by dividing the amount of change from 65-69 to 80-84 by the higher score so that the proportion of change would be calculated in the same manner as other fitness scores.

Table 6 Fitness Means and Percentage of the 65 over Portuguese population meeting age- and gender-specific fitness standards associated with independent functioning (Rikli & Jones, 2012).

	Age groups			
	65-69	70-74	75-79	80-84
30 s chair stand - Women				
Fitness standards (US data), reps	15.0	14.0	13.0	12.0
Portuguese mean scores, reps	15.2	14.9	12.5	9.8
% meeting standard	56.8%	61.2%	50.8%	36.0%
30 s chair stand - Men				
Fitness standards (US data)	16.0	15.0	14.0	13.0
Portuguese mean scores	16.4	14.8	12.9	11.3
% meeting standard	56.7%	54.0%	46.8%	40.8%
30 s arm curl - Women				
Fitness standards (US data), reps	17.0	16.0	15.0	14.0
Portuguese mean scores, reps	17.7	17.3	15.1	12.4
% meeting standard	58.4%	62.7%	54.7%	39.4%
30 s arm curl - Men				
Fitness standards (US data), reps.	18.0	17.0	16.0	15.0
Portuguese mean scores, reps.	19.0	18.2	16.0	14.6
% meeting standard	61.3%	62.5%	55.4%	49.4%
6-min walk - Women				
Fitness standards (US data), m	523	530	503	466
Portuguese mean scores, m	487	454	378	304
% meeting standard	29.7%	27.6%	20.2%	14.5%
6-min walk - Men				
Fitness standards (US data), m	594	567	530	485
Portuguese mean scores, m	544	500	433	350
% meeting standard	43.3%	39.0%	33.3%	18.9%
8 ft up and go - Women				
Fitness standards (US data), s	5.3	5.6	6.0	6.5
Portuguese mean scores, s	6.8	7.4	9.8	13.5
% Meeting standard	38.5%	41.6%	29.3%	18.3%
8 ft up and go - Men				
Fitness standards (US data), s	5.1	5.5	5.9	6.4
Portuguese mean scores, s	5.9	7.4	9.0	10.3
% meeting standard	50.5%	41.6%	34.4%	20.6%