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HIGHER LEVELS OF PHYSICAL FITNESS ARE ASSOCIATED WITH A REDUCED RISK OF SUFFERING SARCOPENIC OBESITY AND BETTER PERCEIVED HEALTH AMONG THE ELDERLY. THE EXERNET MULTI-CENTER STUDY

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Abstract: *Objective:* To evaluate the associations between physical fitness levels, health related quality of life (HRQoL) and sarcopenic obesity (SO) and to analyze the usefulness of several physical fitness tests as a screening tool for detecting elderly people with an increased risk of suffering SO. *Design:* Cross-sectional analysis of a population-based sample. *Setting:* Non-institutionalized Spanish elderly participating in the EXERNET multi-centre study. *Participants:* 2747 elderly subjects aged 65 and older. *Measurements:* Body weight, height and body mass index were evaluated in each subject. Body composition was measured by bioelectrical impedance. Four SO groups were created based on percentage of body fat and relative muscle mass; 1) normal group, 2) sarcopenic group, 3) obesity group and 4) SO group. Physical fitness was evaluated using 8 tests (balance, lower and upper body strength, lower and upper body flexibility, agility, walking speed and aerobic capacity). Three tertiles were created for each test based on the calculated scores. HRQoL was assessed using the EuroQol visual analogue scale. *Results:* Participants with SO showed lower physical fitness levels compared with normal subjects. Better balance, agility, and aerobic capacity were associated to a lower risk of suffering SO in the fittest men (odds ratio < 0.30). In women, better balance, walking speed, and aerobic capacity were associated to a lower risk of suffering SO in the fittest women (odds ratio < 0.21) Superior perceived health was associated with better physical fitness performance. *Conclusions:* Higher levels of physical fitness were associated with a reduced risk of suffering SO and better perceived health among elderly. SO elderly people have lower physical functional levels than healthy counterparts.

Key words: Elderly, sarcopenia, obesity, physical fitness, HRQoL.

Introduction

Aging is a continuous process characterized by a decline in several physiological systems. An important change in the musculoskeletal system, recognized among the elderly, is the loss of muscle mass (sarcopenia) and low muscle function (strength or performance) (1, 2). This phenomenon is associated with serious consequences for the individual, such as physical disability, comorbidities and mortality, and for society, increasing economic and social costs (1, 3). Further, aging involves changes in body composition, with a progressive increase in percentage of body fat mass (BF%) (4), increasing the risk of developing overweight and obesity in the elderly population, with associated consequences such as cardio-metabolic complications, physical limitations, and worse health-related quality of life (5). In this sense, the presence of reduced muscle mass and increased fat mass is commonly known as sarcopenic obesity (SO) (1). As we have previously stated, the prevalence of SO in the non-institutionalized elderly in Spain is 18% in men and 14% in women (6).

The impact of SO on physical function has been given considerable attention in the gerontology literature (7-10). Physical capacity has generally been assessed through self-report measures, because it is less time consuming and it does not require adequate space, special equipment or special training for examiners and it does not compromise the subject's health (11). However, questionnaires have methodological limitations which limit the external validity of their results, requiring additional information obtained with objective physical performance testing to provide optimal assessment and adequate interpretation of results (11, 12).

According to the American College of Sports Medicine (13) and others (14, 15), aerobic capacity, muscular endurance and muscle strength, body composition and flexibility are the components of physical fitness most linked to health. However, few studies have used physical performance testing to analyze the relation between body composition and physical function in elderly populations.

The traditional way to identify people who have too much body FM is through the body mass index (BMI), which has great limitations in older people (5). On the other hand, for measuring muscle mass more sophisticated methods are

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required. For this reason, in spite of having numerous adverse health effects, SO in older people can often go unnoticed.

The goals of the current study were to determine the association between physical fitness levels, health related quality of life (HRQoL) and SO using objective measures of body composition and physical fitness, in a large and well-characterized cohort of non-institutionalized elderly. Additionally, the usefulness of various physical fitness tests as a tool for detecting elderly people with an increased risk of suffering SO was examined.

Methods

Participants

The study was carried out within the framework of the elderly EXERNET multi-centre study. The complete methodology of the study has been described elsewhere (16, 17). In brief, this study was performed on a representative sample of non-institutionalized Spanish seniors aged 65–92 years. The population was selected by means of a multistep, simple random sampling, taking into account, first, the locations (six different regions in Spain: Aragón, Castilla-La Mancha, Castilla-León, Madrid, Extremadura and Canarias) that ensured the geographical and cultural diversity of the sample, then three different cities in each region and, finally, by random assignment of the civic and sports centres. The total number of subjects was uniformly distributed in the six regions and in their corresponding cities. The exclusion criteria were: people under 65 years; those who were living in nursing homes and/or were not independent or able to take care of themselves and those suffering from dementia and/or cancer. The information was collected through personal interviews using a structured questionnaire, followed by a physical examination to measure anthropometric characteristics. In this study, a sample of 2747 older adults was analyzed. Written informed consent was obtained from all the subjects included. The protocol was approved by the Clinical Research Ethics Committee of Aragón (18/2008). The ethical guidelines for human research studies as stated in the Helsinki Declaration were followed throughout the study.

Anthropometric and body composition measurements

A portable stadiometer with 2.10 m maximum capacity and a 0.001 m error margin (SECA, Hamburg, Germany) was used to measure height according to standardized methods (18).

Body mass, percentage of fat mass and muscle mass

A portable bioelectrical impedance analyser TANITA BC 418-MA (Tanita Corp., Tokyo, Japan) with a 200 kg maximum capacity and a +/- 100 g error margin was used to measure the body mass, %BF and the muscle mass. Individuals removed shoes, socks and heavy clothes prior to weighing.

Sex-specific (%BF) cut-off values published by Gómez-Cabello et al.(6) were used for creating SO groups. For women, the limits for %BF quintiles were (i) 35.06; (ii) 35.07–38.28; (iii) 38.29–40.90; (iv) 40.91–43.90 and (v) 43.91. The corresponding boundaries for men were (i) 25.18; (ii) 25.19–27.82; (iii) 27.83–30.33; (iv) 30.34–33.07 and (v) 33.08. Full-body skeletal muscle mass was estimated with the predictive equation developed by Janssen et al. (19) Skeletal mass (kg) = ([Ht2/R x 0.401] + [sex x 3.825] + [age in years x -0.071]) + 5.102, where Ht = height in cm, R = resistance in ohms from bioelectrical impedance analysis and sex = 0 for women and 1 for men. To account for differences in muscle mass as a function of height, relative muscle mass (RMM) was calculated as skeletal muscle (kg)/height2 (m2). As with %BF, the RMM was divided into sex-specific quintiles to facilitate the interpretation of odds ratios. For women, the ranges for RMM quintiles were (i) 5.80; (ii) 5.81–6.19; (iii) 6.20–6.56; (iv) 6.57–7.00 and (v) 7.01. The corresponding ranges for men were (i) 8.11; (ii) 8.12–8.61; (iii) 8.62–9.01; (iv) 9.02–9.50 and (v) 9.51.

Body mass index (BMI) was calculated as body weight in kilograms divided by the square of height in meters. The prevalence of overweight and obesity was calculated according to the World Health Organization guidelines, considering the thresholds of overweight and obesity as a BMI of 25 kg/m2 and 30 kg/m2, respectively (20).

Following previous published criteria for defining SO (21), four groups were created by cross-tabulating quintile scores for %BF and RMM. High body fat was defined as the upper two quintiles for %BF, and low muscle mass was defined as the lower two quintiles for RMM. Body fat in the lower three quintiles and muscle mass in the upper three quintiles were considered normal. Using these cut-offs, the four groups included were (i) normal body fat and muscle mass; (ii) high body fat only (and normal muscle mass); (iii) low muscle mass only (and normal body fat) and (iv) high body fat in combination with low muscle mass (SO).

Physical fitness assessment

The following physical fitness components were assessed: static balance by the one leg test (22), lower and upper body strength by the chair stand test and arm curl test, respectively (23), lower and upper body flexibility by the chair sit-and-reach test and back scratch test, respectively (23), agility/dynamic balance by the 8-foot up-and-go test (23), speed by the 30-m walk (24) and aerobic capacity by the 6-min walk test (23). All the tests were performed only once, except the one leg test, which was performed twice with each leg, the 8-foot up-and-go test and the 30-m walk test, which were also performed twice.

In the current study, three different categories (tertiles) were created for each fitness test based on the calculated scores and according to sex. The low tertile was composed of subjects who had the worst results in each fitness test, while the high tertile was composed of subjects who had the best results in each fitness test.

Health-related quality of life (HRQoL)

Quality of life was assessed using the validated questionnaire EuroQol-5D (EQ-5D) (25, 26) which has been used in elderly people before (27). The EQ-5D essentially consists of two parts, the EQ-5D descriptive system and the EQ visual analogue scale (EQ_VAS). The EQ_VAS records the respondent's self-rated health on a vertical, visual analogue scale where the endpoints are labelled "Best imaginable health state" (100 points) and "Worst imaginable health state" (0 points). This information can be used as a quantitative measure of health status as judged by the individual respondents. The EQ_VAS was used to assess the perceived health of each subject at that moment, establishing values equal to or more than 80 points as a good indicator of perceived health.

Statistical analysis

Descriptive data were calculated for all dependent variables as means (M) and standard deviations (SD) according to sex. The normal distribution of the variables was examined with the Kolmogorov–Smirnov test. Statistical differences between sexes were compared with the Student's t test. The relationship of SO with all fitness tests and HRQoL was analyzed initially with a general lineal model (fixed factor: SO groups and interaction with a covariate variable: age). We observed that SO groups had significative interaction with all fitness tests (except for the back scratch test) andHRQoL, independently of age. Binary logistic regression was used to test the association among all physical fitness tests and the independent variables (SO and HRQoL) by sex. Odds ratios with 95% confidence intervals (CI) are reported for the studied models. Model I included the independent variable. Model II incorporated age as possible confounder. SPSS Statistics 19.0 software was used to analyze the data (SPSS Inc., Chicago, USA). Statistical significance was set at $p<0.05$.

Results

Table 1 shows mean values for physical characteristics of the sample by sex. All variables, except age, were significantly different between sexes, with men obtaining a higher physical performance than women in all physical fitness tests, except for flexibility (all $p\leq0.01$).

A total of 442 elderly people presented SO (15.5% of men and 16.3% of women). In women, compared with the normal group (normal body fat and muscle mass), those with SO were older. In both sexes, the SO group obtained lower physical fitness results in all tests (Table 2). Figure 1 and 2 show lower risks for having SO in those placed in the highest tertile and medium tertile for each physical fitness test compared with those placed in the lowest tertile by sex. In men, the three principal physical fitness tests associated to a lower risk of suffering SO were static balance, agility, and aerobic capacity by 0.27, 0.28 and 0.30, respectively (95% CI [(0.14-0.52); (0.15-0.53) and (0.15-0.58)]. In women, the risk of suffering from SO was lowered by 0.17, 0.20 and 0.21 in those in the highest tertile for static balance, walking speed, and aerobic capacity, respectively (95% CI [(0.12-0.25); (0.13-0.29) and (0.14-0.31)].

In relation to HRQoL, 48% of the sample reported scores of 80 points or above for quality of life. All physical fitness variables presented significant differences between those placed in the highest tertile of each physical fitness test compared with those placed in the lowest tertile in both sexes (Table 3). Better perceived health in men was associated with better physical fitness performance (highest tertile) by 3.17, 3.14 and 3.07, in aerobic capacity, agility, and lower body

Table 1

Participants' characteristics by sex

	Men		Women		
Test	**n**	**Mean ± SD**	**n**	**Mean ± SD**	**p**
Age (y)	645	72.4 ± 5.4	2102	72.0 ± 5.2	0.090
Body weight (kg)	640	77.2 ± 10.8	2095	68.3 ± 10.5	<0.001
Height (cm)	645	165.5 ± 6.6	2102	152.8 ± 5.9	<0.001
BMI (kg/m^2)	640	28.2 ± 3.4	2095	29.2 ± 4.3	<0.001
Body fat (%)	645	29.0 ± 5.3	2102	39.2 ± 5.4	<0.001
One leg balance test (s)	615	31.9 ± 22.8	2023	25.4 ± 20.4	<0.001
Chair stand test (rep)	619	15.3 ± 3.7	2020	14.3 ± 3.4	<0.001
Arm curl test (rep)	608	17.2 ± 3.8	1966	16.3 ± 3.8	<0.001
Chair sit-and-reach test (cm)	614	-8.6 ± 12.0	2032	-2.2 ± 9.7	<0.001
Back scratch test (cm)	619	-17.3 ± 12.4	2021	-10.3 ±9.9	<0.001
8-foot up-and-go test (s)	622	5.4 ± 1.5	2032	5.9 ± 1.6	<0.001
30-m walk test (s)	567	15.4 ± 3.7	1949	17.8 ± 3.8	<0.001
6 minute walk test (m)	567	566.9 ± 94.5	1927	515.9 ± 88.0	<0.001
HRQoL (score)	566	7.5 ± 1.6	1849	7.2 ± 1.8	<0.001

Note: Values are mean ± standard deviation (Mean ± SD); BMI, body mass index; HRQoL, health-related quality of life; n = number of participants. Values refer to significant sex effect calculated using Student t-test.

Table 2
Physical fitness tests and HRQoL score by sex and compared among body composition groups

Test	Men				Women			
	Normal group (n=234)	Sarcopenic group (n=151)	Obesity group (n=160)	SO group (n=100)	Normal group (n=770)	Sarcopenic group (n=505)	Obesity group (n=485)	SO group (n=342)
One leg balance test (s)	37.9±22.1[ab]	34.4±23.0[ab]	24.3±21.1	25.9±22.0	30.3±20.9[ab]	27.9±20.7[ab]	20.4±18.5	17.5±17.5
Chair stand test (rep)	16.0±3.7[ab]	15.6±4.1	14.6±3.3	14.5±3.6	14.8±3.4[ab]	14.9±3.6[ab]	13.6±3.2	13.4±3.2
Arm curl test (rep)	17.6±3.8	17.6±4.2	16.5±3.6	16.8±3.5	16.5±4.0	16.6±3.8	16.1±3.6	15.8±3.6
Chair sit-and-reach test (cm)	-6.8±11.9	-8.7±12.5	-9.9±11.3	-10.6±12.1	-1.1±8.8[ab]	-1.9±10.0	-3.3±10.3	-3.7±10.3
Back scratch test (cm)	-15.2±11.8[ab]	-16.7±12.2	-19.8±12.4	-19.3±13.0	-8.3±9.2[ab]	-8.6±9.4[ab]	-13.1±9.9	-13.5±10.7
8-foot up-and-go test (s)	5.1±1.2[ab]	5.5±1.4	5.8±1.7	5.7±1.6	5.6±1.2[ab]	5.8±1.5[ab]	6.3±1.9	6.4±1.9
30-m walk test (s)	14.6±2.6[ab]	15.2±3.6[a]	16.5±5.2	15.9±3.1	17.0±3.0[ab]	17.4±3.5[ab]	18.5±4.1	19.3±4.9
6 minute walk test (m)	585.2±89.6[ab]	575.7±91.8[a]	551.2±96.7	534.5±95.5	538.6±81.1[abc]	523.3±83.4[ab]	492.9±88.5	484.2±92.4
HRQoL (score)	7.8±1.5[b]	7.6±1.6[b]	7.0±1.8	7.4±1.7	7.4±1.8[ab]	7.3±1.8[ab]	6.9±1.9	6.9±1.8

Note: HRQoL, health related quality of life. SO, sarcopenic obesity. Values are mean ± standard deviation (Mean ± SD); Normal group, normal body fat and muscle mass; Sarcopenic group, normal body fat and low muscle mass; Obesity group, high body fat and normal muscle mass; SO group, high body fat in combination with low muscle mass; n = number of participants; Differences between groups and according to sexes were calculated using a general lineal model (fixed factor: SO groups and covariate variable: age). aSignificant differences with respect to SO group; bSignificant differences with respect to Obesity group; cSignificant differences with respect to Sarcopenic group. p≤0.05.

Table 3
Odds ratio for having good HRQoL in those placed in the highest and medium tertiles of each physical fitness test compared with those placed in the lowest tertile

	Men			Women		
	Lowest physical fitness tertile	Medium physical fitness tertile	Highest physical fitness tertile	Lowest physical fitness tertile	Medium physical fitness tertile	Highest physical fitness tertile
One leg balance test (s)						
Model 1	1	1.18 (0.78-1.78)	1.78 (1.17-2.70)*	1	1.59 (1.26-2.01)**	2.02 (1.60-2.55)**
Model 2	1	1.17 (0.77-1.78)	1.73 (1.09-2.73)*	1	1.62 (1.28-2.06)**	2.10 (1.63-2.69)**
Chair stand test (rep)						
Model 1	1	1.66 (1.13-2.44)*	3.14 (1.96-5.04)**	1	1.43 (1.13-1.80)*	1.90 (1.52-2.37)**
Model 2	1	1.62 (1.10-2.39)*	3.07 (1.91-4.94)**	1	1.42 (1.13-1.79)*	1.88 (1.50-2.35)**
Arm curl test (rep)						
Model 1	1	1.73 (1.14-2.61)*	2.22 (1.46-3.37)**	1	1.20 (0.96-1.51)	1.85 (1.47-2.35)**
Model 2	1	1.71 (1.13-2.60)*	2.16 (1.42-3.28)**	1	1.19 (0.95-1.50)	1.83 (1.44-2.32)**
Chair sit-and-reach test (cm)						
Model 1	1	1.39 (0.92-2.09)	1.65 (1.09-2.49)**	1	1.29 (1.03-1.62)*	1.52 (1.21-1.91)**
Model 2	1	1.36 (0.90-2.04)	1.59 (1.05-2.42)*	1	1.29 (1.02-1.61)*	1.50 (1.19-1.88)**
Back scratch test (cm)						
Model 1	1	1.71 (1.13-2.58)**	1.79 (1.17-2.69)**	1	1.35 (1.07-1.70)*	1.77 (1.41-2.22)**
Model 2	1	1.69 (1.12-2.55)**	1.71 (1.12-2.60)**	1	1.34 (1.06-1.70)*	1.76 (1.40-2.23)**
8-foot up-and-go test (s)						
Model 1	1	3.54 (2.30-5.45)**	3.18 (2.08-4.87)**	1	1.63 (1.30-2.06)**	2.10 (1.66-2.65)**
Model 2	1	3.52 (2.27-5.43)**	3.14 (2.01-4.89)**	1	1.66 (1.32-2.11)**	2.16 (1.69-2.77)**
30-m walk test (s)						
Model 1	1	1.10 (0.72-1.68)	2.03 (1.31-3.13)**	1	1.65 (1.31-2.08)**	2.13 (1.68-2.71)**
Model 2	1	1.06 (0.68-1.65)	1.94 (1.22-3.07)*	1	1.70 (1.34-2.15)**	2.23 (1.73-2.87)**
6 minute walk test (m)						
Model 1	1	1.32 (0.87-2.02)	3.19 (2.03-5.00)**	1	1.54 (1.22-1.94)**	2.16 (1.70-2.75)**
Model 2	1	1.32 (0.86-2.04)	3.18 (1.99-5.08)**	1	1.58 (1.25-2.00)**	2.27 (1.76-2.92)**

Note: HRQoL, health related quality of life; n = number of participants. Model 1, unadjusted; Model 2, adjusted for age. Data are presented as odds ratio (95% confidence interval). *P≤0.05; **P≤0.001

strength, respectively (95% CI [(1.99-5.08); (2.01-4.89) and (1.91-4.94)]. In women, the odds ratio of having better perceived health was associated with better physical fitness performance (highest tertile) by 2.27, 2.23 and 2.16, aerobic capacity walking speed, and agility, respectively (95% CI [(1.76-2.92); (1.73-2.87) and (1.69-2.77)].

Discussion

This study, aimed to answer three issues of great importance. Firstly, to analyze whether SO is a risk factor related to loss of functional disability. Secondly, to assess the predictive capacity of fitness for predicting SO and, finally, to know whether a better physical fitness level is associated with higher self-perceived health.

To our knowledge, this is the first study, including a representative national sample of non-institutionalized elderly, to investigate the association between SO and physical fitness using objective and validated measures of physical performance and body composition.

Figure 1
Odds ratio (OR) for having SO in those placed in the highest and medium tertiles of each physical fitness test compared with those placed in the lowest tertile in men. The circles and triangles represent ORs and the bars represent the 95% confidence interval (CI). Logistic regression analysis was controlled for age. (*p≤0.05, **p≤0.001)

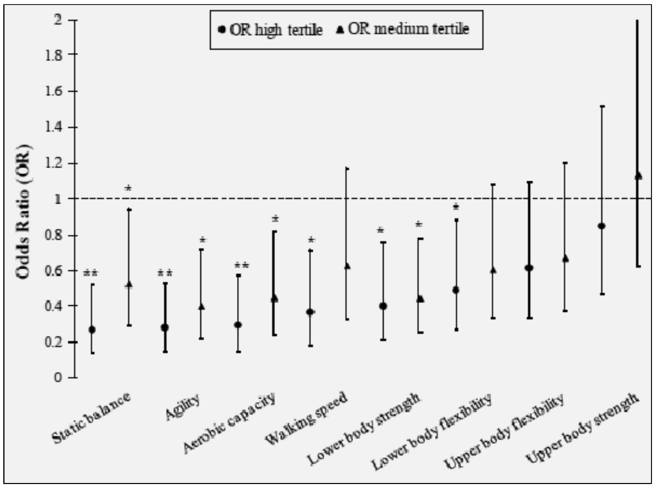
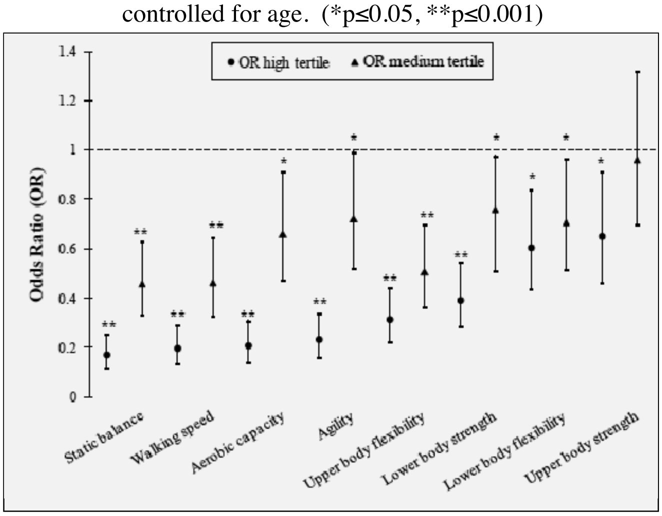


Figure 2
Odds ratio (OR) for having SO in those placed in the highest and medium tertiles of each physical fitness test compared with those placed in the lowest tertile in women. The circles and triangles represent ORs and the bars represent the 95% confidence interval (CI). Logistic regression analysis was controlled for age. (*p≤0.05, **p≤0.001)



Both increased BF and decreased muscle mass may act synergistically increasing the risk of disability. Our results indicate that the elderly with SO perform worse than the elderly with normal values of BF and muscle mass. However, there is a discrepancy in the literature, as results about association of functional decline and disability with age-related changes in body composition differ from one study to another. Accordingly, several studies have reported that the loss of skeletal muscle mass, observed with advancing age, linked to obesity is associated with functional impairments and disability (8, 10, 28, 29). In this sense, Waters et al. (28) evaluated 183 older adults (29 with SO) using four functional performance measures (chair stand test, step touch test, timed one-legged stand and the timed get up and go test) and concluded that SO has a negative impact on physical function. On the other hand, several studies have not found functional differences between normal and SO groups or have reported that BF is the most important risk marker for disability (7, 9, 30). Messier et al. (30) performed a graded exercise test on an ergocycle with 136 overweight and obese postmenopausal women; only 9 women were SO and no significant differences were found between the sarcopenic and non-sarcopenic groups. Our results indicate that SO men and women do not display lower physical fitness compared to non sarcopenic obese individuals, with obesity appearing to contribute more per se than sarcopenia.

The fact that worse levels of physical activity are associated with an increased risk of sarcopenia and SO is an issue that has also been studied (31, 32). Despite no physical fitness levels being assessed in their study, Ryu et al. (32) in a representative sample of older Koreans, concluded that men and women participating in high levels of physical activity have significantly lower risk to suffer from SO. In our study, after analyzing physical fitness in all subjects through validated physical capacity tests, we found that subjects with higher levels of fitness were less likely to have SO, corroborating studies to date.

As SO prevalence is increasing, we have identified the need to develop methods based on low cost and easily available tools for early detection. This aspect is very important for physical activity professionals, because it can be used as a screening tool to identify elderly people at risk of suffering SO and refer them to the health center. Therefore, as mentioned above, another purpose of our study was to determine whether some physical fitness tests included in this study could be used for predicting the risk of SO in older people. In our study, according to the odds ratios, we identified that static balance and aerobic capacity were the best tests to predict the risk of SO in both sexes, followed by two walking tests (walking speed in women and agility/dynamic balance in men). It is known that physical activity decreases with age (33) favoring sedentary behaviors which are associated with increasing overweight and obesity in old people and with a decrease in physical fitness (34, 35). Several studies have reported that obesity is an independent factor for postural instability (7, 10, 36). In this sense, a high BMI compromises walking for longer distances, raising the body center of mass from a chair or up a flight of stairs (37). Moreover, there is evidence about a decline in muscle mass and leg strength with aging (38). Sarcopenia of the lower extremities is particularly important as it may lead to various physical dysfunctions (39). Lower limb muscle strength, especially of the knee extensors, has shown to be an important factor for balance control (36, 40). Ochi et al (36) investigated the relationship between age-related quadriceps sarcopenia and visceral obesity on postural instability finding an association with postural instability in middle-aged to elderly subjects. In this sense, we can conclude that older obese people with low muscle strength have an increased risk of losing their balance and walking ability and experiencing accelerated decline of lower extremity performance (28, 41, 42). In a longitudinal analysis from the InCHIANTI Study, Stenholm et al. (41) reported that obesity combined with low muscle strength increases the risk of decline in walking speed and developing mobility disability, especially among persons under age 80. Other researchers corroborate these results (43-45). All of which contribute to confirm that these tests are the best predictors of the risk of SO.

The last purpose of this study was to know whether a higher level of physical fitness is associated with better perceived health since another important dimension of health is self-perfection and well-being. There are some studies which have found associations between physical activity and perceived HRQoL while associations between fitness and perceived HRQoL have been less studied, especially in older people. Therefore, we took the advantage of our representative sample and included this analysis in our study. In line with previous findings (46-50), higher fitness values were positively associated with better self-rated health in the studied elderly. It is necessary to know which aspects of physical fitness are most important for older people is necessary, since increasing those physical fitness capacities could contribute to improvements in their HRQoL. In this line of work, Olivares et al (27) identified those physical fitness tests that were more related to the perception of HRQoL in a sample of 7104 middle-aged and older adults using the EQ-5D. Their fitness battery included upper body strength, upper and lower body flexibility, balance, agility and aerobic capacity tests and their study results showed a better association of agility and aerobic capacity with HRQoL dimensions.

Our results corroborate the results mentioned above, since two of the fitness tests that associated most closely with a better HRQoL were aerobic capacity and agility/dynamic balance, in both sexes. However, it should be noted that, in our study lower-body strength and walking speed were also assessed showing a close positive association with HRQoL, the latter being consistent with previous studies (49).

The present study is not exempt from limitations. The cross-sectional design of the study does not allow the establishment of a cause-effect relationship between SO and physical fitness variables. The sample was composed of voluntaries therefore, the non-institutionalized elderly with low muscle mass and/or low muscle strength, might have been less likely to participate in the study. Body composition was assessed by BIA, which has proved to be a valid method. The analysis of the data were made for sex and adjusted for age so the finding could be limited by other uncontrolled variables.

Based on the observed results, this study provides evidence that older persons with SO present significantly worse physical fitness compared with older people who do not have sarcopenia or obesity. Moreover, lower physical fitness levels were associated with an increased risk of suffering SO, as static balance, aerobic capacity and walking tests (walking speed in women and agility/dynamic balance in men) were the most sensitive physical fitness capacities associated with the risk of suffering OS. . Finally, higher physical fitness levels were associated with a better HRQoL perception suggesting its importance in increasing quality of life in older adults.

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