Prevalence of sarcopenia among community-dwelling, young elderly people living in Manizales, Colombia

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Abstract: The role of sarcopenia in the elderly has received increased attention across a number of disciplines in recent years. In 2010 the European Working Group on Sarcopenia in Older People (EWGSOP) defined the condition as the loss of muscle mass plus low muscle strength or low physical performance, associated with age. There is little published research on this issue in Colombia and South America. The purpose of this study was to determine the prevalence of sarcopenia according to the criteria of the EWGSOP in the elderly population of Colombia who live in the community. Two hundred and ten subjects were studied. Muscle mass (the main component of sarcopenia as it is defined) was estimated by bioelectrical impedance analysis from which the skeletal muscle mass index was calculated. Muscle strength was measured through hand dynamometry and physical performance using the Short Physical Performance Battery (SPPB). Based on the reference values which are themselves based on U.S. or Asian population reference cut off points, an overall prevalence of sarcopenia of 52.8% or 15.7% respectively was found. The prevalence of sarcopenia in the studied population is within the ranges reported worldwide in different populations. However, there are variations depending on the cut off points and diagnostic tools used for its definition and to estimate muscle mass.

1. Introduction

Sarcopenia refers to the age-dependent loss of skeletal muscle mass [1]. This loss starts around the fourth decade of life and is related to a 1% annual loss of strength [2]. The determinants of sarcopenia include genetic and environmental factors, with a complex series of poorly understood interactions [3]. Well-recognized life course influences on muscle mass and strength include age, gender, heritability, adult body size, physical activity, nutrition and comorbid disease [3,4].

Several studies have consistently documented associations between the loss of skeletal muscle mass and unfavorable outcomes on the health of community-dwelling elderly [2]. This phenomenon, correlated with fragility, falls, loss of function and autonomy, implies a greater risk of acquiring diseases and dying. Its prevalence is estimated at 5 to 13% among adults aged between 60 and 70 and 11 to 50% among people over the age of than 80 [5]. Patients with sarcopenia are at an increased risk of disabilities, ranking between 2 and 5 times as likely, in comparison with those without this condition [6]. In 2010 the European Working Group on Sarcopenia in Older People (EWGSOP) defined the condition as the loss of muscle mass plus low muscle strength or low physical performance, associated with age [7, 8].

In Colombia, life expectancy has increased. In 2009, it was estimated at 73.07 years for men and 78.58 for women [9]. Thus, having reliable data on the prevalence of sarcopenia and its effects on the health of the elderly is essential for the development of health promotion programs. The purpose
of this study was to determine the prevalence of sarcopenia according to the criteria of the EWGSOP in the elderly population of Colombia who live in the community.

2. Materials and Methods

2.1. Participants
Dwelling Older adults living in the community in Manizales were recruited. The inclusion criteria were aged between 65 and 75 years old and living in the community. The exclusion criteria were living in nursing homes, having a decompensated chronic disease, pacemakers, chronic kidney disease in hemodialysis, presence of edemas, metallic non removable pieces or prosthesis, diuretic consumption, limb amputation, hemiparesis or hemiplegia which did not allow the potential subject to be tested using the bioimpedance technique. The study protocol was reviewed and approved by the Ethics Committee of the University of Caldas.

2.2. Recruitment
The sample was evaluated using registries of the National Administrative Department of Statistics. 1085 older individuals who were randomly selected were eligible and 213 of these agreed to participate. All participants provided written consent.

2.3. Definition of sarcopenia and its spectrum
Sarcopenia was defined using the EWGSOP criteria, which requires the presence of low skeletal muscle mass and low physical performance or low strength. Presarcopenia was defined as the presence of low skeletal muscle mass without abnormalities in physical performance or strength. Severe sarcopenia was defined as the presence of these three parameters [2, 7]. The test set was applied to each participant.

2.4. Skeletal Muscle Mass Index
A bioelectrical impedance data acquisition system (Hydra 4200, Xitron Technologies, San Diego, USA) was used to determine bioelectrical impedance. Current electrodes were placed on the dorsal surfaces of the right hand and foot, and detector electrodes were placed on the right wrist and ankle. This system uses electric current to directly measure the amount of extracellular and intracellular water in the body and indirectly estimate the fat-free mass. A value for skeletal muscle mass was determined, and then converted into the skeletal muscle mass index (SMI) by dividing by weight by height squared. This index has been recommended for EWGSOP as a measurement of variable muscle mass [2, 7]. Taking into account the absence of Colombian data regarding anthropometric parameters, extrapolated data were taken from two different reference cut off points, both recommended for EWGSOP: NHANES III [10] from the Mexican-American population group, and those from Chien et al [11] obtained from an Asian population since some authors revealed that Native Americans descend from at least three different Asian genetic influxes [12].

2.5. Physical strength
The grip strength of the dominant hand was measured three times using a hand dynamometer (Baseline®). The maximum value was used in all further calculations. Handgrip strength is also recommended for EWGSOP as a measurement of physical strength variable [2,7].

2.6. Physical performance
The Spanish adapted Short Physical Performance Battery SPPB included timed measurements of walking speed, rising from a chair and maintaining balance. For the walking test, participants were asked to walk 4 meters, turn around, and walk back the 4 meters at usual speed. For the chair standing test, participants were asked to fold their arms across their chest and to stand up from a sitting position and sit down five times as quickly as possible. For the ability to maintain balance in
tandem standing, the participants was asked to put the heel of one foot in front of the other and to stand still for as long as possible. Those who could not complete the task had a score of 0. Those completing the task were assigned scores of 1 to 4, corresponding to the quartiles of time needed to complete this, with the fastest time recorded as 4. The performance total score was calculated by adding all the scores that ranged from 0 to 12. A SPPB score ≤ 10 indicated a low physical performance and a score > 10 indicated normal physical performance [13,14].

2.7. **Socio-demographic characteristics**
Socio-demographic variables were assessed through survey questions and self-assessment. Those were age, gender, education (measured as years of formal schooling from 0 to 18), marital status, smoking (measured as smoking index: number of cigarettes smoked per day/number of years smoked), physical activity, work activity and health insurance.

2.8. **Health status variables**
These included self-perceived health status (assessed by asking “How would you evaluate your present health?” Responses included good, fairly good and poor), perceived weakness status (assessed by asking “Would consider yourself a weak person? Answers included yes or no), presence of chronic conditions and comorbidities (diagnosed by a physician). Sarcopenia and 100% of those who had obesity grade I did not have any degree of the disease.

2.9. **Anthropometric parameters**
Weight, height, calf circumference and body mass index were measured according to standardized protocols.

2.10. **Statistical analyses**
A descriptive analysis was carried out using absolute and relative frequencies for qualitative variables; and mean and standard deviation for quantitative variables. The degree of relationship between quantitative variables was analysed by the Pearson correlation coefficient. Comparison of variables was performed by a bivariate analysis using the statistic x2. A p value <0.05 was considered a statistically significant difference to define. A multinomial logistic regression was carried out based on the variables in which statistically significant differences were found in the bivariate analysis, in order to assess the strength of the associations. The data obtained were analysed using the SPSS-PC 21.0 (SPSS, Chicago, IL).

### 3. Results
Two hundred and ten seniors were assessed (124 women and 86 men), with a mean age of 69.2 (+/- 3.0) (Table 1). The mean BMI was 25.3 (3.58 SD). 68.1% of the participants were doing physical activity. Comorbidities were reported by the elderly, and the most prevalent were cardiovascular diseases (40.1%), metabolic diseases (25.2%) and osteoarticular diseases (20.5%).

Most participants did not smoke or never had (91.8%). The mean SPPB score was 9.84 Kg/m2 (10.34 in the men and 9.49 in the women). Mean values of all muscle mass measurements obtained by BIA and muscle strength were higher in men.

Conflicting results were found when muscular mass criteria proposed by EWGSOP was considered: less than 10.76 kg/m2 in men and 6.76 kg/m2 in women as reference values based on statistical analysis of NHANES III [10] or SMI less than 8.87 kg/m2 in men and 6.43 kg/m2 in women as reference values for the study of Chien *et al* [11].

Based on the reference values which were based on NHANES III [10] or Chien *et al* [11], an overall prevalence of sarcopenia of 27.6 % or 9.5% was found. Adding the prevalence of presarcopenia, the overall results were 52.8% and 15.7% respectively.
Table 1. Characterization of the elderly of Manizales, Caldas.

| Variables                        | Men (n=86) | Women (n=124) | Total (n=210) |
|----------------------------------|------------|---------------|---------------|
| **Age**                          | 69.03 (3.1)| 69.3 (3.1)    | 69.22 (3.0)   |
| **Socioeconomic stratum**        |            |               |               |
| Low                              | 23 (25.6%) | 37 (30%)      | 59 (27.1%)    |
| Medium                           | 42 (52.4%) | 55 (44.4%)    | 97 (46.2%)    |
| High                             | 22 (19.6%) | 32 (25.7%)    | 68 (25.7%)    |
| **Self-assessed health**         |            |               |               |
| Good (n - %)                     | 68 (79.1%) | 74 (59.7%)    | 142 (67.6%)   |
| Average and poor (n - %)         | 18 (20.9%) | 50 (40.3%)    | 68 (32.4%)    |
| **Self-perception of weakness**  |            |               |               |
| Yes (n - %)                      | 11 (12.8%) | 34 (27.4%)    | 45 (21.5%)    |
| **Smoking (pack/year)**          |            |               |               |
| 0 (n - %)                        | 74 (86%)   | 117 (94.4%)   | 191 (91.8%)   |
| 1 – 19 (n - %)                   | 4 (4.7%)   | 4 (3.2%)      | 8 (3.8%)      |
| 20 – 39 (n - %)                  | 4 (4.7%)   | 1 (0.8%)      | 5 (2.4%)      |
| More than 40 (n - %)             | 4 (4.7%)   | 2 (1.6%)      | 6 (2.9%)      |
| **Chronic diseases**             |            |               |               |
| Cardiovascular Diseases          | 36 (41.9%) | 48 (38.7%)    | 84 (40.1%)    |
| Metabolic Diseases               | 14 (28.6%) | 39 (31.4%)    | 53 (25.2%)    |
| Osteoarticular Diseases          | 11 (12.8%) | 32 (25.8%)    | 43 (20.5%)    |
| Respiratory Diseases.            | 5 (5.8%)   | 10 (8.1%)     | 15 (7.1%)     |
| **Anthropometry**                |            |               |               |
| Weight (kg)                      | 68.1 (9.3) | 59.5 (10.3)   | 63 (10.7)     |
| Height (m)                       | 1.66 (6.0) | 1.51 (5.9)    | 1.57 (9.3)    |
| BMI (kg/m$^2$)                   | 24.6 (2.8) | 25.8 (3.9)    | 25.3 (3.58)   |
| Calf circumference               | 35.2 (2.5) | 33.3 (2.9)    | 30.1 (2.91)   |
| **Functionality**                |            |               |               |
| Dominance                        | 83(96.5%)  | 121(97.6%)    | 204(97.2%)    |
| Grip Strength (max)              | 35.4 (6.6) | 21.2 (5.2)    | 27.06 (9.1)   |
| **Short Physical Performance Battery (SPPB)** | | | |
| SPPB total score (0-12)          | 10.34 (1.62)| 9.49 (1.73)  | 9.84 (1.74)   |
| Balance (0-4)                    | 3.9 (0.28) | 3.8 (0.52)    | 3.86 (0.44)   |
| Gait Speed (0-4)                 | 3.26 (0.82) | 2.84 (0.85)  | 3.01 (0.86)   |
| Rising from a chair (0-4)        | 3.14 (0.93) | 2.85 (0.93)  | 2.97 (0.94)   |

Because there is some evidence that Latin, South Americans are phenotypically more similar to Asians than Americans [12] the results were based on these cutting points. Previous epidemiological studies of sarcopenia in several countries in which diagnostic criteria of EWGSOP are used for the evaluation of muscle mass show different results (Table 2) [10, 11, 15, 16, 17, 18].
Table 2. Prevalence of sarcopenia in different population groups.

| Populations | n   | Men | Women | Diagnostic Method | Cut off points | Prevalence % |
|-------------|-----|-----|-------|-------------------|---------------|--------------|
| Manizales   | 210 | 177 | 137   | BIA               | < 8.87 kg/m²  | 9.30         |
|             |     |     |       |                   | < 6.42 kg/m²  | 8.80         |
| Taiwan      | 157 | 145 | 125   | BIA               | < 8.87 kg/m²  | 23.60        |
|             |     |     |       |                   | < 6.42 kg/m²  | 18.60        |
| EU          | 1241| 1217| 124   | DXA               | < 10.76 kg/m²| 17.78        |
|             |     |     |       |                   | < 6.76 kg/m²  | 14.93        |
| Italy       | 345 | 385 | 368   | BIA               | < 8.87 kg/m²  | 34.20        |
|             |     |     |       |                   | < 6.42 kg/m²  | 18.60        |
| Japan       | 568 | 1314| 435   | BIA               | 6.75 kg/m²    | 21.80        |
|             |     |     |       |                   | 5.07 kg/m²    | 22.00        |
| Belgium     | 103 | 185 | 83    | BIA               | 8.87 kg/m²    | 12.62        |
|             |     |     |       |                   | 6.42 kg/m²    | 12.43        |
| Chile       | 319 | 687 | 307   | DXA               | < 7.19 kg/m²  | 19.40        |
|             |     |     |       |                   | < 5.77 kg/m²  | 18.90        |

Participants were classified according to the presence of presarcopenia, sarcopenia and severe sarcopenia (Table 3). The relationship between age and sarcopenia showed that participants between the age of 65 and 70 had a prevalence for any degree of sarcopenia in 7.6% of males and 11.5% of females, while for older participants, (aged between 70 and 75 years) the figure was 30.3% in men and 20% in women, which shows a statistical difference in the univariate analysis ($p = 0.007$).

It was found that 9.3% of men and 8.8% of women were sarcopenic, 79 of the participants have a low score in SPPB. Out of these, 8.9% had severe sarcopenia, 6.3% sarcopenia and 84% did not have sarcopenia. The prevalence of sarcopenia and severe sarcopenia was higher in those who did not do any exercise.

A relationship between smoking and sarcopenia was found. Out of participants who had a severe history of smoking, 20% had sarcopenia and 40% had severe sarcopenia while, amongst those who were non-smokers 86.7% had no sarcopenia and only 13.3% had some degree of sarcopenia. In bivariate analysis a statistically significant association was found between sarcopenia and smoking ($p<0.000$). By carrying out the logistic regression model this association persisted, resulting in statistically significant relationship between smoking and the presence of sarcopenia with OR 2.561 ($p=0.003$) as show in Table 3.

On evaluating the relationship between BMI and sarcopenia it was found that amongst those with low BMI, 80% had some degree of sarcopenia as follows: 20% pre-sarcopenia, 20% sarcopenia and 40% severe sarcopenia. On the other hand, out of those who were overweight, 85% did not have sarcopenia and 100% of those who had grade 1 obesity did not have any degree of the disease.

Table 3. Prevalence of Sarcopenia in Manizales.

| Classification        | No. | %   |
|-----------------------|-----|-----|
| No sarcopenia         | 177 | 84.2|
| Presarcopenia         | 13  | 6.2 |
| Sarcopenia            | 13  | 6.2 |
| Severe Sarcopenia     | 7   | 3.3 |
| Total                 | 210 | 100.0|

4. Discussion

These results suggest that prevalence of sarcopenia in community dwelling older people under the age of 75, identified with EWGSOP criteria is relatively high in Manizales. Large differences were found in the data obtained when diagnosing sarcopenia and the components of the spectrum (presarcopenia, sarcopenia, severe sarcopenia), arising from the use of different cut off points for the evaluation of muscle mass. Using reference ranges from NHANES III [10], it was observed that
men are more likely to be diagnosed as presarcopenia and sarcopenia, but there are differences between men and women with severe sarcopenia. Using the cut off points from Chien et al [11], the behavior of the data was similar for both sexes, except in severe sarcopenia, where more women had severe sarcopenia.

When comparing the overall results obtained for muscle mass using the cut off points from NHANES III [10] or from Chien et al [11], it was observed that prevalence of sarcopenia was considerably greater with the former. The fact that the observed results using the Asian cut off points matched more closely with those reported in scientific literature on prevalence of sarcopenia in participants under 75, could validate the recommendation to use Asian anthropometric parameters with the South American population, however this assumption requires more evidence.

Epidemiological data available suggest that prevalence of sarcopenia varies widely; according the criteria used for the selection of the subjects. In this case, the obvious difference in muscle mass date, (the main variable for diagnosing sarcopenia), affects the characterization of our population and undoubtedly may affect health interventions. In a systematic review, Cruz-Jentoff et al [19], evaluated the prevalence of sarcopenia using EWGSOP criteria, in community-dwelling, elderly European, Asian and North Americans. They found that 1 to 29% of subjects suffered from this condition, especially women (30%). Factors explaining this variability, apart from the studied population, are the different methods used for the measurement of muscle mass, physical strength and physical performance. Even so, these factors can also be attributed to real differences in the prevalence of sarcopenia. Nevertheless, the prevalence reported for Manizales is within the range documented by Cruz-Jentoff et al [19].

Other factors such as chronic inflammation, stroke, rheumatism, fall–related injuries, and sedentary lifestyles can affect the prevalence of sarcopenia [20]. An interesting association was found between the development of sarcopenia and smoking. There is also some evidence that smoking may impair physical function [21] and probably increase the risk of sarcopenia. In a meta-analysis it was found that cigarette smoking may increase the chance of developing sarcopenia. However, the results could be particularly affected by a relatively small number of studies included and their high heterogeneity [22]. Despite these limitations data suggest a biological plausibility in this association. Petersen et al, 2007 [23] found that the basal rate of mixed muscle protein synthesis was markedly reduced in heavy smokers compared to age matched individuals who had never smoked. Although these results do not prove causality, the documented association between cigarette smoking and sarcopenia in Manizales study provides another piece of epidemiological evidence for this association.

There are some limitations in the current study. Since there are no studies of body composition in the young Colombian population, applying cut off points defined as the average muscle mass of young people from other countries (USA, Taiwan) may lead to some inaccuracies when estimating prevalence of sarcopenia. Given the increasing importance of this condition in the geriatric population it will be very important to improve the knowledge of body composition in the Colombian population. Additionally, in a future study it would be advisable to take into account other variables that were not considered in this one, such as ADL, quality of life and living space, among others.

On the other hand, the work has some strengths. This is the first study on the prevalence of sarcopenia in a representative population sample of Colombian, dwelling - living elderly. The data provided will allow a more comprehensive approach to risk assessment of adverse outcomes related to this condition which, until, had remained unknown to the Colombian medical environment.

Another strength of this study is the use of the electrical bioimpedance technique for muscle mass evaluation because it is more convenient than measurements using anthropometric parameters. Although the determination of muscle mass by bioimpedance is less sensitive than CT, MRI or DEXA, it is more economical, does not require specialized personnel, can be done in the patient’s bed and gives immediate results.

It is also essential to determine the prevalence of sarcopenia in the whole country and, even more importantly, to continue with epidemiological studies to define the appropriate reference values. This tool should be included for everyday use in the geriatric approach within the multidimensional geriatric assessment, mainly in low-resource settings such as in Colombia.
5. Conclusion
In this study the importance of sarcopenia as a topic for public health and the importance of the method to determine sarcopenia are highlighted. The results showed that prevalence of sarcopenia in the studied population is within the ranges reported worldwide within different populations. However, there are variations depending on the cut off points and diagnostic tools used for its definition and to the estimate muscle mass. Thus, it is important to obtain reference points for each country and make comparisons when similar instruments have been utilized to estimate the muscle mass component of body composition.

Conflict of interest
No conflicts of interest are declared by authors.

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