Original article

Determination of normative reference for the definition of sarcopenia among Filipinos

Michael L. Tee a,*, Cherica A. Tee b, Elizabeth B. Montemayor a

a Department of Physiology, College of Medicine, University of the Philippines Manila, Philippines
b National Institutes of Health, University of the Philippines Manila, Philippines

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Abstract

Background: At present, there is no normative value that can be used in the definition of sarcopenia in the Philippines.

Objective: We identified the reference cut-off values for: 1) muscle mass using bioimpedance analysis; 2) grip strength; 3) usual gait speed; 4) timed get-up-and-go; and 5) short physical performance battery in the Philippines in order to adapt the European Working Group on Sarcopenia in Older People (EWGSOP) criteria for the definition of sarcopenia.

Methods: Two hundred seventy six (135 males and 141 females) healthy Filipino adults, between 20 and 40 years, were included in this cross-sectional study. A Fresenius Body Composition Monitor was used to measure lean tissue mass (LTM) and lean tissue index (LTI). A dynamometer was used to measure grip strength. Usual gait speed, timed get-up-and-go, and short physical performance battery were also determined.

Result: The normative references for males and females, respectively, for LTI were $17.10 \pm 2.337 \text{ kg/m}^2$ and $12.63 \pm 2.119 \text{ kg/m}^2$; for usual gait speed were $1.06 \pm 0.251 \text{ m/sec}$ and $0.930 \pm 0.144 \text{ m/sec}$; and for grip strength were $39.76 \pm 7.567 \text{ kg}$ and $26.68 \pm 5.243 \text{ kg}$. The sarcopenia cut-points for the males and females, respectively, for LTI were $<12.50 \text{ kg/m}^2$ and $<8.33 \text{ kg/m}^2$; for usual gait speed were $<0.55 \text{ m/sec}$ and $<0.65 \text{ m/sec}$; and for grip strength were $<24.54 \text{ kg}$ and $<16.10 \text{ kg}$.

Conclusion: This study presents cut-points for the determination of sarcopenia at-risk population among Filipinos.

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Keywords: Impedance; Anthropometry; Sarcopenia

1. Introduction

The aging of world population has been identified as a key concern that the U.N. Population Fund created Global AgeWatch Index [1] to address the dearth of international data on the extent and impact of global aging. In the Philippines, life expectancy at 60 years old is pegged at 17 years, while healthy life expectancy at 60 years old is at 14 years [2]. The four-year difference between life expectancy and healthy life expectancy at 60 years old, therefore, poses a challenge in the formulation of national policies that will close the gap and ensure healthy life among those 60 years old and above.

The last decade saw a rapid increase in the number of elderly Filipinos from 4.6 million senior citizens or about 6% of the total population in the year 2000 to 6.5 million or about 6.9% of the total population in 2010 [3]. With an increasing number of Filipinos 60 years old and above, old age-related illnesses and morbidities will become major concerns in the delivery of health care. Thus, efforts to prevent illnesses associated with advanced age can be a major strategy in health care delivery savings.

* Corresponding author. Department of Physiology, College of Medicine, UP Manila, 2/F Salcedo Hall Building, 547 Pedro Gil Street, Ermita, Manila 1000, Philippines.
E-mail address: mltlee@up.edu.ph (M.L. Tee).
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One of the most important age-related conditions that lead to decreased functional capacity and physical disability among older people is sarcopenia. It is a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength [4]. The impact of sarcopenia has been quantified in a number of studies on morbidity [5], disability [6], high costs of health care [7], and mortality [8]. Several studies have shown that poor strength, function, and low muscle density are linked to hospitalization in elderly [9]. Physical activity and total energy expenditure have been significantly correlated with dementia [10]. Alzheimer pathology has also been linked to lower body weight [11].

While sarcopenia is a syndrome associated with older-age individuals, the condition is a relatively young field of study. In fact, it was only in 2009 that the European Union Geriatric Medicine Society (EUGMS) created the European Working Group on Sarcopenia in Older People (EWGSOP) to propose the measurement tools, standard parameters, and variables that can be used to establish its diagnosis [4]. In their 2010 consensus report, EWGSOP defined sarcopenia as low muscle mass and either low muscle strength or low physical performance.

In Asia, sarcopenia’s impact is reckoned to be vast because the region is rapidly aging with a huge population [12]. Hence, the Asian Working Group for Sarcopenia (AWGS) endeavors to promote sarcopenia research. Over the last few years, it has gathered the finest existing evidences from the countries in the region to determine the consensus for sarcopenia diagnosis. In its 2014 consensus report, the AWGS has concurred with the previous reports that sarcopenia should be defined as low muscle mass plus low muscle strength and/or low physical performance [12].

Several techniques have been validated for the identification of sarcopenia. These include computed tomography, magnetic resonance imaging, dual X-ray absorptiometry, bioimpedance analysis (BIA), and total and partial body potassium per fat free soft tissue. Among these, it is the BIA that carries the double advantage of accuracy and portability. It estimates the volume of fat and lean body mass. The test itself is inexpensive, easy to use, readily reproducible, and appropriate for both ambulatory and bedridden patients. The BIA measurement techniques, used under standard conditions, have been studied for more than 10 years [13].

Muscle strength measurement can also be accomplished using various techniques. These include anthropometric measures, handgrip strength, short physical performance battery, usual gait speed, and timed get-up-and-go test. In all these studies, the reference value for determining the abnormal can be a limitation.

Different measurement techniques require the availability of a reference value. EWGSOP advocates the use of normative (healthy young adult) rather than other predictive reference populations. The cut-off points recommended is two standard deviations below the mean reference value. It also notes the urgent need to obtain good reference values for populations around the world. In Asia, due to its huge populace and diverse ethnicities, selecting appropriate diagnostic cut-off values for all the measurements has been a challenge [12].

In defining sarcopenia, EWGSOP recommends the use of normative data derived from the study population rather than using other population. This recommendation reflects the understanding that body composition may be affected by race and environmental factors like food variety and physical activity. To date, there is no available Philippine normative value that can be used to diagnose sarcopenia.

This paper aimed to establish the normal muscle mass and physical performance in the Filipino population in order to improve the applicability of the EWGSOP criteria. The cut-off values to be used in determining at-risk population among the elderly were then identified. This study used BIA, anthropometric measurements, isometric hand grip to measure muscle strength gait speed, timed get-up-and-go test, and functional independence measure to establish the standards, in accordance with the EWGSOP recommendations.

2. Materials and methods

2.1. Population and sampling

This cross sectional study examined 276 healthy adults, 135 male and 141 female subjects, in the age range of 20–40 years. The sample size computation was based on the paper of C. Jennen-Steinmetz and S. Wellek titled “A new approach to sample size calculation for reference interval studies.” Stratified sampling was used based on age and sex proportionate to the 2015 age-sex distribution published by the National Statistical Coordination Board (NSCB) in the National Statistics Office (NSO) website. Subjects were recruited among the students, faculty and staff of the University of the Philippines Manila (UPM), including doctors, nurses, allied health professionals, technicians, and maintenance personnel.

This sampling was predicated on the assumption that healthy members of the UPM community aged 20–40 years can adequately represent the population of the country, for a tolerable limit of 3.7% and fixed probability of 90% for a 95% reference interval (two-sided). This was sufficient since the study used a one-sided interval. Subjects were excluded if they: 1) had any physical impairment that prevented them from performing the required physical tests; 2) were unable to follow instructions; or 3) had BMI <18.5 or >29.9.

This study was approved by the Departmental Technical Review Board and University of the Philippines Manila Research Ethics Board. Considering the lack of biosafety concern in studies such as this, no further clearance was obtained from a biosafety committee. Informed consent forms duly approved by the institutional ethics review board were taken from all subjects. Participants were interviewed and examined to obtain relevant demographic and health information.

2.2. Data collection procedures

2.2.1. Muscle mass

This study used the Fresenius Body Composition Monitor to determine lean tissue mass and lean tissue index. Standard manufacturer protocol was followed.
2.2.2. Grip strength

The subjects were asked to stand and hold the dynamometer in the hand to be tested, with the arm at right angles and the elbow by the side of the body. The handle of the dynamometer was adjusted to ensure that its base rested on the first metacarpal (heel of palm), while the handle rested on the middle of four fingers. When ready, the subjects squeezed the dynamometer with maximum isometric effort, which was maintained for about five seconds. No other body movement was allowed. The subjects were strongly encouraged to give maximum effort. The assistant recorded the maximum reading in kilograms (kg). The subjects repeated the test three times, with 30 s rest in between. The assistant recorded the highest value to document each subject’s performance.

2.2.3. Anthropometric measures

1) Weight. The subjects were asked to remove heavy outer garments and shoes and empty their pockets. They were also asked to stand in the center of the platform. The weights were moved until the beam balanced. The weight was recorded to the resolution of the scale (the nearest 0.1 kg or 0.2 kg).

2) Height. This study used a stadiometer to measure the height. The subjects were asked to remove their shoes, heavy outer garments, and hair ornaments. They were then asked to stand with their back to the height rule. The back of the head, back, buttocks, calves, and heels touching the upright rule, feet together. It was ensured that the top of the external auditory meatus (ear canal) was leveled with the inferior margin of the bony orbit (cheek bone). They were also asked to look straight. The measuring rod was then lowered so that the hair (if present) was pressed flat on the subjects' head. Height was recorded to the resolution of the height rule (i.e. nearest millimetre/half a centimetre). If the participant was taller than the measurer, the measurer stood on a platform so that he/she can properly read the height rule.

3) Waist to hip ratio. The waist circumference was measured at a level midway between the lower rib margin and iliac crest with the tape all around the body in horizontal position. The subjects were asked to remove their clothes covering the torso to hip, except for light underwear. The subjects also loosened their tight clothing, including the belt, and the pockets emptied. The measurer stood at the side of the subjects in order to have a clear view of the mirror. The subjects stood with their feet fairly close together (about 12–15 cm), with their weight equally distributed to each leg. The subjects were also asked to breathe normally as the measurement was read at the end of a gentle exhale. This prevented the subjects from contracting their abdominal muscles or from holding their breath. With the measuring tape at horizontal position and loose enough to allow the observer to place one finger between the tape and the subjects’ body, the measured was recorded to the resolution of the tape (nearest millimetre/half centimetre). The hip circumference was measured as the maximal circumference over the buttocks. The grid lines on the mirror were used to verify that the tape position was horizontal all around the body.

2.2.4. Usual gait speed

This test was adapted from the four-meter walk test in the Short Physical Performance Battery. The subjects were asked to walk a short distance (four meters) at their usual pace. They had to complete one practice and then two timed trials. Raw scores were recorded as the time in seconds required to walk four meters on each of the two trials, with the better trial used for scoring.

2.2.5. Timed get-up-and-go

The subjects were asked to rise from sitting on a standard arm chair, walk three meters, turn, walk back to the chair, and sit down, which required them to wear regular footwear. The time in seconds for each subject to do these activities was measured. The best of three trials was recorded.

2.2.6. Short physical performance battery

2.2.6.1. Balance test. a) Side-by-side stand. The subjects were asked to stand with feet together, side-by-side, for about 10 s. The stopwatch stopped after 10 s or when the subjects stepped out of position or grabbed the arm of the assistant. The results were recorded in seconds.

b) Semi tandem stand. The subjects were asked to stand with the side of the heel of one foot touching the big toe of the other foot for about 10 s. Either foot may be placed in front; whichever was comfortable to the subjects. The results were recorded in seconds.

c) Tandem stand. The subjects were asked to stand with the heel of one foot in front of and touching the toes of the other foot for about 10 s. Either foot may be placed in front; whichever was comfortable to the subjects. The results were recorded in seconds.

2.2.6.2. Gait speed test. a) First gait speed test. The subjects were asked to walk four meters at their usual speed. The time to complete the course was then recorded in meters/second.

b) Second gait speed test. The subjects were asked to repeat the four-meter walk at their usual speed. The time to complete the course was again recorded in meters/second.

2.2.6.3. Chair stand test. a) Single chair stand. The subjects were asked to fold their arms across their chest and sit so that both feet were on the floor. They were then asked to stand up while keeping their arms folded across their chest. Their ability to do the tasks was documented according to the scoring criteria.

b) Repeated chair stands. The subjects were asked to fold their arms across their chest and sit so that both feet were on the floor, then they were asked to repeatedly stand up and sit down for five times while keeping their arms folded across their chest. The stopwatch stopped when the subjects had straightened up completely for the fifth time; when they used their arms; after one minute and the subjects had not completed the rises; or at the discretion of the assistant, when concerned for the subjects’ safety. The results were recorded in seconds.
2.3. Statistical analysis

The data were entered into an Excel worksheet and were verified by a second independent person. Data analysis was done separately according to sex. Descriptive statistics, such as mean, standard deviation for normally distributed continuous variable, and relative frequencies for qualitative values, were generated for all data. The cut-off values for grip strength, body mass index (BMI), and lean tissue index were defined as -2SD below the mean. For usual gait speed and timed get-up-and-go, the cut-off values were defined as +2SD above the mean.

3. Results

This study’s reference population included a total of 276 healthy adults, 135 male and 141 female subjects, with ages between 20 and 40 years. The mean age was 28.92 ± 5.573 years for male and 28.52 ± 5.551 years for female. Table 1 presents the demographic and anthropometric profile of healthy Filipino adults. Table 2 presents the cut-off values to be used in determining at-risk population to sarcopenia among the elderly Filipinos.

4. Discussion

Sarcopenia is a growing concern in an aging population. In addition, the possibility of unrecognized risk factors that may accelerate the development of sarcopenia and frailty must be attended to. The absence of a normative reference against which to define the condition is a major constraint in efforts to minimize its impact in the elderly population’s quality of life. The identification of appropriate measuring tools and definition of cut-off values that are consistent with international standards will allow researchers and policy-makers to adapt actions and recommendations by groups like EWGSOP.

4.1. Using BIA to measure lean tissue index

While it is recognized that whole body MRI provides the most accurate measurement of skeletal muscle mass, its use is limited by inconvenience, affordability, and access. Even the more recently evaluated dual-energy X-ray absorptiometry (DEXA) shares the same issues that limit its utility in field studies [14].

Thus, this study used BIA in measuring lean tissue mass. Chien and colleagues have compared BIA with magnetic resonance imaging and concluded that it provides results consistent with the more cumbersome and expensive magnetic resonance imaging [15]. Further, their study validated the use of the prediction equation for surveying sarcopenia in Asians.

A crucial consideration is the fact that BIA is an EWGSOP accepted alternative in estimating muscle mass to be used in normative reference studies.

A lean tissue index of <12.50 kg/m² for male and <8.33 kg/m² for female will, henceforth, define sarcopenia among Filipinos. This value is greater than the cut-off recently set by Bahat et al. for the Turkish population at 9.2 kg/m² and 7.4 kg/m² in males and females, respectively [16].

4.2. Using handgrip strength

In this study, Jamar dynamometer was used. Adult Filipino men and women have grip strength of 39.76 ± 7.567 kg and 26.68 ± 5.243 kg, respectively. This is within the reference range presented by the PURE study group (34–44 kg in men and 19–27 kg in women <60 years from South East Asia) [17].

Grip strength of <24.54 kg and <16.10 kg for the males and females, respectively, are the cut-off values in determining elderly Filipinos at risk to sarcopenia. This value is less than the cut-off value recommended by the AWGS in clinical practice, which is < 26 kg for men and <18 kg for women [12].

4.3. Using BMI

In this study, we used the latest low to moderate risk BMI range for public health action set in 2002 during the WHO expert consultation on BMI in Asian populations in Singapore (18.5 kg/m² to 27.5 kg/m²). The mean BMI of healthy Filipino...
adults included in setting our normative reference was 24.36 ± 2.531 kg/m² for males and 23.39 ± 2.863 kg/m² for females, well within the international classification of BMI cut-off points set by the WHO, which is 18.5–24.9 kg/m² for normal range [18]. The subjects included can be categorized into increasing but acceptable risk with cut-off point that varies from 18.5 to 23 kg/m², and increased risk that ranges from 23 to 27.5 kg/m² [18]. Since this is a study on sarcopenia and frailty, the authors deemed it better to include subjects who are healthy and with BMI that is below the cut-off for obesity in order to avoid the negative impact of excess fat in bioimpedance analysis.

5. Conclusion

This study provides the reference data for the definition of normal muscle mass, strength, and physical performance among young Filipino individuals. These data will be used in the determination of age-related decline of the values presented in Tables 1 and 2. In the future, these data will be used as bases in setting target improvement values should the Department of Physiology be able to create biomechanical apparatus to minimize the impact of sarcopenia. In addition, these data can be used in illness-correlation studies that can lead to formulation of prescription diet and physical activities among hospitalized patients with the goal of preventing hospitalization-related decline in physical function.

Conflicts of interest

None.

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