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Research paper

Calf circumference predicts mobility disability: A secondary analysis of the Mexican health and ageing study

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ABSTRACT

Introduction: Calf circumference is a surrogate measurement of muscle mass. However, there is scarce evidence on its validity in predicting adverse outcomes such as mobility disability. The aim of this report is to determine if calf circumference could predict incident mobility disability in Mexican 60-year or older adults.
Methods: This is a secondary analysis of the Mexican Health and Aging Study and in particular of its two first waves. Sixty-year or older adults without mobility disability in the first assessment were included and followed-up for two years. Calf circumference quartile groups were compared to test the difference of incident mobility disability. Logistic regression models were fitted to test the independent association when including confounding variables.
Results: A total of 745 older adults were assessed, from which 24.4% of the older adults developed mobility disability at follow-up. A calf circumference $>$ 38 cm was associated with a higher risk of developing mobility disability, even after adjustment in the multivariate model, with an odds ratio 0.55 (95% confidence interval 0.31–0.99, $P = 0.049$).
Conclusions: High calf circumference in Mexican older adults is independently associated with incident mobility disability. This could reflect the impact of adverse health conditions such as obesity (with high fat tissue) or edema. Further research should aim at testing these results in different populations.

1. Introduction

One of the main concerns of older adults health is nutrition. This concern is depicted in the latest years with an increasing interest in sarcopenia and associated conditions (e.g. sarcopenic obesity). Sarcopenia has shown to be closely related to aging and aging-related conditions [1]. There are a number of tools that measure body composition with different accuracy, from anthropometry to magnetic resonance imaging [2,3], in order to assess muscle mass or fat tissue. The measurement of calf circumference (CC) reflects low muscle mass and has been validated with the current reference standard (compared to Dual-energy X-ray absorptiometry [DEXA], $r = 0.63$), and has shown to be useful predicting adverse outcomes such as mortality and dependency [4,5]. In addition, a high CC in populations with elevated frequency of obesity it could be a marker of sarcopenic obesity [6]. Either way (low or high), it is a marker of malnourishment and potentially associated with sarcopenia. On the other hand, CC assessment is an easy to perform measurement that provides clinically useful information that can aid in the decision-making process in older adult health care [5–8]. This is especially true in contexts in which specialized resources for older adult care are scarce [9,10]. Moreover, along with new research in CC, there is an increasing interest in generating surrogates of the measurement of muscle mass with ready available information (epidemiologic, anthropometric, health-related, etc.) [11,12].

In 2010, Cruz-Jentoft et al. proposed an algorithm in order to detect sarcopenia in which along with muscle mass measurement, physical performance tests were also included (gait speed and handgrip strength) [13]. This algorithm has been increasingly used in clinical and research settings, as shown in a recent systematic review in which studies using the algorithm were several hundreds (in just four years) [14]. Physical performance tests are easy to evaluate in older adults and have shown good validity in predicting adverse outcomes in a number of settings [15–18]. The same is true for recommended muscle mass measurement tools DEXA and bioelectrical impedance analysis (BIA) [2]; however, in contrast to the other components of the algorithm, these tools are not available

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everywhere, need specialized personnel to be performed, are more expensive and not very popular even among geriatricians [19]. Notwithstanding, there are an increasing number of reports that use the algorithm using CC as the muscle mass measurement [20–25].

In contrast to gait speed and handgrip strength – the other two components of the algorithm – CC lacks of evidence of its potential predictive value of mobility disability. The aim of this study is to assess the predictive ability of CC in predicting mobility disability in a group of community-dwelling older adults (60 years and over) from the Mexican Health and Aging Study (MHAS).

2. Materials and methods

This is a secondary analysis of the MHAS and in particular from the baseline assessment (2001) and the second wave (2003). Complete methods and objectives are available elsewhere [26,27]. In brief, there are three waves of this study with a probabilistic sample of Mexican adults aged 60 years or older (2001, 2003 and 2012). A set of questionnaires (socio-demographic characteristics, health-related issues, access to health services, migration status, cognitive performance, functional status, and financial resources) was applied to all the participants. In addition, each wave included a sub-sample in which anthropometric measurements and blood samples were also obtained.

A total of 15,402 subjects were assessed in 2001 (which included adults with less than 60 years), and a 20% ($n = 2573$) randomly selected sub-sample was drawn to obtain anthropometric measurements, such as: height, weight, calf circumference, knee height, hip and abdominal circumferences. After exclusion of subjects with less than 60 years and those with mobility disability already in 2001; the final sample was of 754 older adults, with complete follow-up to 2003.

Mobility disability was defined as having difficulty to walk one block or having difficulty to climb one flight of stairs, as previously used with physical performance tests in older adults [15,28]. As previously stated, older adults with this condition in the first assessment were excluded from the analysis.

CC was measured in the most prominent region of the leg with the older adult in a sitting position with both legs on the floor and relaxed, three measurements were performed and the highest one was registered in centimetres [29]. Further categorization of CC was done by quartiles (for each sex group); these groups were used in the following analyses (see below).

Confounding variables were included in order to test the independent association of CC with incident mobility disability such as socio-demographic characteristics: age in years, sex, marital status (married, single, divorced or widower), currently working (including domestic chores), and years in school. Smoking status (never smoked, smoked in the past and currently smoking), and physical activity (having done exercise regularly in the past two years) were included as habits that could impact overall health. Finally health-related variables included self-rated health (excellent, very good, good, fair, poor), self-rated vision (excellent, very good, good, fair, poor), self-rated hearing (excellent, very good, good, fair, poor), pain (chronic and constant), weight loss (unintentional loss of 5 or more kilograms in the last two years), cognitive decline, significant depressive symptoms, falls, body mass index (weight/squared height), and a sum of comorbidities (including hypertension, diabetes mellitus, cancer, lung disease, ischemic cardiac disease, stroke, and articular disease). Subjects were considered to have cognitive decline if they failed in two or more sub-tests of the brief version of the Cross Cultural Cognitive Examination [30]. Regarding depression a score of 5 or higher was considered as significant depressive symptoms as already validated in Mexican older adults [31].

Descriptive statistics included frequencies (absolute and relative) for categorical variables, means and standard deviation (SD) for continuous variables and medians with inter-quartile ranges (IQR) for ordinal ones. In order to assess significance of the difference for each variable when comparing the group with incident mobility disability with the group without incident mobility disability further tests were performed: *t*-tests (continuous) and Wilcoxon rank-sum tests (ordinal) were performed along with Fisher's exact test to categorical variables. Finally a logistic regression was fitted estimate the odds ratio (OR) for predicting mobility disability of quartiles of CC, comparing the groups (without reference group). Unadjusted and adjusted models (for significant variables only) are reported; OR along with 95% confidence intervals (CI) and *P*-values were obtained. All analyses were performed with STATA 14® statistical software.

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3. Results

From a total of 754 60-year or older adults, 50.8% were women and the mean age of the sample was of 67.39 years (±SD 6.43). The majority of older adults were married (64.32%) and currently worked (61.8%). The median of years in school was 3 (IQR 0–19). A total of 267 older adults (35.41%) did vigorous physical activity in the last year and up to 415 (55.04%) have never smoked. Perception of health was mainly fair (46.68%), vision and hearing perception were more frequently reported as good (42.04% and 54.91% respectively). Regarding geriatric conditions pain, falls, depression and cognitive decline were common with a frequency of 30% or above. The median number of comorbidities was one (IQR 0–5). The mean of the BMI was 26.72 kg/m^2 (±SD 4.32) and CC 35.6 cm (±SD 3.02) (see Table 1). The mean BMI for each of the CC quartiles was (from the lowest to the highest); Q1 = 23.7 kg/m^2, Q2 = 26.5 kg/m^2, Q3 = 27.9 kg/m^2, Q4 = 30.3 kg/m^2.

Overall incidence of mobility disability was of 24.4% ($n = 184$). Regarding the significance between the group with incident mobility disability and without mobility disability only smoking status and BMI were not significantly different, while the rest of the variables were significantly different or with a significant trend. Specifically for the CC quartile groups, incidence of mobility disability was lower for the third quartile (Q3) group (16.22%); for the rest of the quartiles the incidence was: 25.51% for the first (Q1), 26.84% for the second (Q2) and 27.22% for the fourth (Q4) (*P*-value = 0.065) (see Table 1).

As shown in Table 2, the only significant association was when comparing Q3 group to the rest of the groups, those in Q3 of CC had a lower risk of incident mobility disability, with the highest effect when comparing Q3 with Q4: OR 0.51 (95% CI 0.29–0.89, $P = 0.02$). The rest of the group comparisons in the unadjusted model were non-significant. In the adjusted model only the Q3 to Q4 comparison was significant: OR 0.55 (95% CI 0.31–0.99, $P = 0.049$) (see Table 2).

4. Discussion

CC predicts incident mobility disability in a group of Mexican community-dwelling older adults. However, older adults with a relatively high CC were those that showed the highest risk (Q4 group). To our knowledge, this is the first study reporting that a high CC could be associated with incident mobility disability. Our