Correlation between Instrumental Activities of Daily Living and muscle mass in older adults: impact of comorbidities.

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Background: There is evidence that sarcopenia and functionality are closely related. However, the association between geriatric syndromes, such as dependence, on instrumental activities and sarcopenia could be affected by the presence of certain comorbidities, such as overweight, obesity, diabetes, and chronic obstructive pulmonary disease (COPD). Therefore, the present study aimed to determine the association between instrumental activities of daily living and muscle mass in the elderly and evaluate the impact of certain comorbidities on this association.

Methods: This was a retrospective analytical observational study, including 1897 patients. Muscle mass was measured with calf circumference, and instrumental activities were measured with the Lawton index.

Results: Among different parameters studies, a statistical correlation was found in a stratified regression analysis between the Lawton index score and muscle mass in patients
who were overweight (p value: 0.001; beta coefficient: 0.08), obese (p value: 0.001; beta coefficient: 0.05), had diabetes (p value: 0.012; beta coefficient: 0.03), and had COPD (p value: 0.001; beta coefficient: 0.03).

**Conclusion:** The correlation between muscle mass and instrumental activities of daily living should be evaluated individually according to the needs of each participant and according to their comorbidities, promoting patient-centered geriatric medicine.

Keyword: Health of the Disabled, Frail Elderly, Functional Status, Muscle, Skeletal

**Introduction**

In 2018, the European Working Group on Sarcopenia in Older People 2 defined sarcopenia and its severity based on three parameters: muscle strength, muscle mass, and physical performance (1). Diagnosing sarcopenia often requires expensive methods such as magnetic resonance imaging, which are challenging with limited resources. Therefore, simpler and less expensive methods are required to estimate the loss of muscle mass accurately. These methods include the measurement of the calf and brachial circumferences, although their use remains controversial (2). Calf circumference is a validated, rapid, and low-cost anthropometric measurement (3) and is usually considered an adjunct to strength, assistance walking, rising from a chair, climbing stairs, and falls sarcopenia screening scale (4,5).

Sarcopenia can have adverse consequences for instrumental activities of daily living, as the loss of muscle mass and strength is related to falls, fractures, and the need for caregiver care (6). One of the most widely used scales for assessing instrumental activities of daily living in older adults is the Lawton instrumental activities of daily living scale (Lawton Scale), which was developed by the Philadelphia Geriatric Center in 1969 and translated into Spanish in 1993. The final score of the Lawton scale is the sum of the values of the responses and varies between zero (maximum dependence) and eight (total independence).
points (7). This instrument is considered a simple index because the information is obtained by asking the patients directly and requires an average time of four minutes to complete (8).

Frail older adults are often in a cycle of recovery from their basic activities and their state of vulnerability. However, one goal of medical care in this population is to prevent advanced dependence and to make instrumental activities of daily living a therapeutic goal to be measured daily to preserve independence in older adults. These activities of daily living are linked to muscle health and should be maintained as a therapeutic goal (9). Therefore, in this study, we determined the association between muscle mass and instrumental activities of daily living in older adults.
Materials and Methods

Design

This observational, analytical, and retrospective study analyzed data from a previous study (Runzer Fernando, Parodi Jose F. (2020): CEMENA Frailty Study. figshare. Dataset. https://doi.org/10.6084/m9.figshare.13059011.v2).

Population

The population of this study was obtained from the CEMENA Frailty Study, which included data from 1897 adult patients aged >60 years recruited from the Geriatrics Service of the Naval Medical Center (CEMENA) of Callao-Peru between 2010 and 2016. The study included older adult outpatient men and women, except for those with cancer, disability, home care, severe dementia, or hospitalization. The objective of the original study was to determine the factors associated with frailty in a non-probabilistic sampling of older adults.

Inclusion and Exclusion Criteria

This study initially included data from all participants in the database. However, 138 participants were excluded due to missing information on the two main variables: muscle mass and dependence on instrumental activities of daily living. Thus, our analysis included data from 1759 participants.

Variables

Functional dependence for instrumental activities was assessed using the Lawton scale, which is an eight-question questionnaire. This index explores the ability of the participants to use the telephone, go shopping, prepare food, take care of the house, do laundry, use transportation, take responsibility for their medication, and manage their financial affairs. A score of zero to one is assigned to each activity according to the need for help in its
execution. The higher the score, the greater the degree of functionality. Functional
dependence was defined as index scores of $\leq 7$ in women and $\leq 4$ in men (10).

Muscle mass was assessed using the calf circumference, which was determined by
measuring the perimeter of the widest section of the distance between the knee and ankle.
The thresholds for normal and altered muscle masses were defined as $\geq 31$ cm and $< 31$ cm,
respectively (11).

Age and sex were determined from medical records. Body mass index (BMI) was measured
using the weight and height evaluated by the researchers at the beginning of the study and
was classified as normal ($< 25$ kg/m$^2$), overweight ($\geq 25$–29.9 kg/m$^2$), or obese ($\geq 30$ kg/m$^2$)
(12).

Data on the remaining variables, including hypertension, diabetes, hypothyroidism, chronic
kidney disease, congestive heart failure, chronic obstructive pulmonary disease (COPD),
lumbar osteoarthritis, knee osteoarthritis, and depression, were collected from the
participants’ clinical records.

Statistical Analysis
We performed the statistical analyses using STATA version 16.0. We calculated the
frequencies and percentages of the main study variables and applied the chi-square test for
bivariate analysis. We used linear regression analysis to calculate the association between
the Lawton Scale score and calf circumference as numerical values. After verifying
compliance with statistical assumptions, we stratified the analysis according to BMI,
hypertension, type 2 diabetes, hypothyroidism, chronic kidney disease, heart failure, COPD.
osteoarthritis, and depression. Our analysis included the calculation of beta coefficients, standard errors, 95% confidence intervals, and p-values.

Ethical Considerations

This study was approved by the Ethics Committee of the National Medical Center. The database used in this study is an open-access "CEMENA Frailty Study" (Runzer Fernando, Parodi Jose F. (2020): CEMENA Frailty Study. figshare. Dataset. https://doi.org/10.6084/m9.figshare.13059011.v2). In the original study, patients were invited to participate and provided informed consent, and the database was analyzed anonymously. We appreciate the logistical support and assistance with reviewing the English writing provided by the team at Universidad Científica del Sur.

Results

The mean age of the participants was 78.41 years (standard deviation, 8.61 years), and males comprised 58.04% of the sample (n = 1018). The results of the descriptive analysis of the study variables revealed that 61.40% of participants (n = 1080) were dependent on instrumental activities of daily living on the Lawton scale, while 61.17% (n = 1076) showed altered muscle mass according to calf circumference. Regarding BMI, participants with BMI <25 kg/m² and overweight showed the highest prevalence rates, at 58.56% (n = 1030) and 24.05% (n = 423), respectively (Tables 1 and 2).

Table 2 shows the results of the bivariate analysis of the covariates and functional dependence according to the Lawton scale. Among participants with functional dependence in instrumental activities of daily living, 62.04% (n = 670) had altered muscle mass; however, the differences were not statistically significant. In contrast, 62.87% (n = 679) of participants with a BMI <25 kg/m² showed functional dependence, which was a statistically significant difference. In addition, we observed functional dependence in 13.15% (n = 142) of participants with hypothyroidism, 23.24% (n = 247) of participants with chronic kidney
disease, 8.24% (n = 89) of participants with congestive heart failure, 27.78% (n = 300) of participants with lumbar osteoarthritis, and 26.20% (n = 283) of participants with knee osteoarthritis. The associations between functional dependence on instrumental activities and these variables were statistically significant.

Table 3 shows the linear regression analysis between calf circumference and Lawton scale score stratified according to the study covariates. We observed statistically significant results for overweight, obesity, diabetes, and COPD, in which calf circumference was positively correlated with the Lawton scale score (Table 3).

Discussion
This study investigated the association between the Lawton scale and muscle mass. The results of the bivariate analysis showed no association; however, in the stratified regression model, we observed a significant correlation between the Lawton scale scores and muscle mass in patients who were overweight, obese, or diabetic and those with COPD.

Regarding the association between muscle mass and instrumental activities of daily living, Cheng et al. reported significant differences between sarcopenia and dependence on instrumental activities, in which 21% of older adults undergoing hemodialysis showed dependence on activities of daily living (13).

In their systematic review and meta-analysis, Wang et al. observed that poor muscle strength was associated with dependence on activities of daily living in 22 of 34 studies and with dependence on instrumental activities of daily living in eight of nine publications. Additionally, poor muscle mass was associated with worsening performance in basic and instrumental activities of daily living among older adults (14).
In contrast, the results of the regression model in a study in the Netherlands that compared muscle parameters with basic and instrumental activities of daily living among hospitalized older adults showed that muscle mass was significantly associated with dependence on basic but not instrumental activities (15). Thus, although most of the literature has reported an association between dependence on instrumental activities and muscle mass, there remains no consensus, and the results vary according to the characteristics of the study populations.

Additionally, in our BMI-stratified regression model, we observed a positive correlation between Lawton scale score and muscle mass among participants who were overweight or obese. Older adults frequently present with sarcopenic obesity, including 0.8% and 5% of the Peruvian population (16). Sarcopenic obesity involves an increase in fat mass coupled with a decrease in muscle mass, which in the long term leads to dependence on performing both instrumental and basic activities of daily living (17). A study in Indonesia observed dependence on instrumental activities of daily living among 25.6% of patients who were overweight or obese (18).

We observed a positive correlation between the Lawton scale score and muscle mass in patients with diabetes. Guerrero-Carreño et al. reported that insulin resistance, diabetic neuropathy, decreased testosterone, and increased pro-inflammatory cytokine levels led to reduced muscle development, contributing to a loss of strength and muscle mass and favoring the development of frailty in older adults (19). Similar findings were described in a study conducted in Ecuador, which observed that 13.04% of patients with diabetes mellitus had high levels of dependence on performing instrumental activities of daily living (20).

Finally, the regression model stratified by COPD revealed a positive correlation between the Lawton scale score and muscle mass. This could be explained by the decrease in ventilatory
capacity in patients with COPD, leading to reduced physical activity and the development of functional and structural inadequacy in different systems, including the musculoskeletal system (21). This factor is more relevant in muscle groups with decreased contractile activity, which explains the greater dysfunction and structural involution of the muscles of the lower extremities in the long term (22). Fernández-García reported that 72.4% of patients with COPD were dependent on instrumental activities of daily living, except for those who were hospitalized because of the exacerbation of the underlying disease (23). Moreover, in their study conducted in Spain, Naval and Gonzalez observed that 24.4% of outpatients diagnosed with COPD were dependent on instrumental activities of daily living (24). Owing to these differences in findings, muscle mass, measurement instruments, and questionnaires are still being investigated. Previous literature and our findings demonstrate the lack of a consistent association between muscle mass and functional measures (25). However, obesity, cardiovascular disease, and the aging process itself are important risk factors for the health of adults worldwide and are related to the pathophysiology of sarcopenia and alterations in instrumental activities of daily life (26).

This study has several limitations. First, we used a cross-sectional design; therefore, we were unable to assess the causality between our variables. Additionally, medical comorbidities were not assessed by the researchers but rather extracted from clinical records from a high-complexity hospital. Finally, because the original study was conducted in a hospital, the frequency of comorbidities may have been higher; thus, our findings may be extrapolated only to hospital populations.

Conclusion

The bivariate analysis in this study showed no association between functional dependence and muscle mass; however, stratified regression analysis revealed a significant correlation between the Lawton Instrumental Activities of Daily Living score and muscle mass in patients who are overweight, obese, diabetic, or who have COPD.
We recommend that the assessment of muscle mass and dependence on functional activities be individualized depending on the comorbidities of each patient, as each comorbidity or medical condition could affect muscle mass and functionality differently, requiring person-centered interventions.