Evaluation of factors influencing handgrip strength asymmetry in elderly Peruvians

Factors influencing handgrip strength asymmetry

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Introduction

As skeletal muscles undergo age-related changes, anabolic impairments contribute to declines in muscle mass, strength, and overall performance(1). This deterioration not only disrupts physical function but also plays a role in the development of geriatric syndromes and conditions, such as sarcopenia, falls, frailty, and functional decline(2,3). One crucial aspect linked with these disorders is handgrip strength (HGS). The HGS test is widely utilized to evaluate mobility, balance, and independent activities of daily living (ADL) (4).

Within the context of clinical tests for assessing muscle strength in older adults, HGS is a reliable measure heavily dependent on neuromuscular function(5). HGS measurements are significant biomarkers of aging and are included in frailty assessments(6). McGrath et al. defined HGS asymmetry as a function of the HGS ratio, which is the ratio of maximum nondominant HGS to maximum dominant HGS(7). Asymmetry of muscle strength is related to functional deficits in older adult populations; however, no studies have demonstrated the variability in risk factors that may increase the risk of decreased muscle strength in this population, although some studies have demonstrated the consequences(8).

Clinicians may encounter HGS asymmetry when assessing physical performance. This occurs when HGS differs significantly between the nondominant and dominant hands. The strength of both hands must be assessed because good strength may bias sarcopenia diagnosis. Indeed, HGS asymmetry is associated with increased instances of disability in ADLs and future accumulation of morbidity and mortality(8,9). Therefore, we assessed factors associated with HGS in older adults from a Latin American city.

Materials and Methods:

Patients and design

This observational cross-sectional study involved the secondary analysis of a database created using data collected in a primary study conducted between 2010 and 2015, which reported the prevalence of factors associated with frailty in older adults treated at the Peruvian Naval Medical Center, Cirujano Mayor Santiago Távara, located in Callao, Peru(10). We excluded patients with cancer, acquired immunodeficiency syndrome, disabilities, or dementia. Although the original study was conducted to study factors associated with frailty, not all patients in the database met the criteria for frailty. After applying the eligibility criteria, 1468 individuals were selected from a population of 1896 older adults.

Selection criteria

The inclusion criteria were age ≥60 years and availability of data on HGS measurements in the dominant and nondominant hands. We excluded 428 patients with missing data on sex (n=5); HGS of the dominant hand (n=9); drug use (n=89); Lawton index (n=72); Functional Reach test (n=77); body mass index (n=89); and history of diabetes (n=23), hypertension (n=7), chronic obstructive pulmonary disease (n=23), depression (n=15), and stroke (n=19).
**Variables**

We evaluated sociodemographic characteristics, such as age and sex. In Peru, due to retirement, the cut-off point defining older adults is 60 years, despite The American College of Sports Medicine suggesting a cut-off point of ≥65 years. We categorized age into 60–79 and ≥80 years, according to the definitions of the Medical Subject Headings terms in MEDLINE. We also constructed a multimorbidity variable, which included a history of diabetes mellitus type 2; chronic kidney disease; arterial insufficiency; arterial hypertension; heart failure; periodontal disease; chronic obstructive pulmonary disease; depression; tobacco use; hip fracture; fractures of the upper and lower limbs and spine; hypothyroidism; stroke; number of falls in the last year; and osteoarthritis of the hand, knee, wrist, and lower back. This variable was divided into categories of <2 and ≥2 comorbidities(11). We calculated obesity using body mass index, which was calculated as weight (kg)/height² (m) and categorized as <30.00 kg/m² and ≥30.00 kg/m². We defined reduced muscle mass as a calf circumference ≤31 cm(12). Likewise, we evaluated the numbers of drugs received, and defined polypharmacy as the consumption of ≥5 drugs(13). A sedentary lifestyle was defined as scores of <64 for men and <52 for women according to the Physical Activity Scale for the Elderly (PASE)(14,15). Functional capacity was measured using the Short Physical Performance Battery (SPPB) scale, and altered physical performance was defined as a score <8(16). The Lawton index measures the ability to perform instrumental activities of daily living (IADL), with scores ≤7 and ≤4 for women and men, respectively, considered as functional impairment(17). According to the Functional Reach Test, the risk of falling was determined for those with a score ≤20.32 cm(18).

**Measurement of HGS asymmetry**

HGS was assessed using a handheld dynamometer (MODEL Dynamometer, series 120286) and measured in kilograms (kg). The test was administered by a trained interviewer. Two measurements were performed, with the better of the two measurements was used for scoring. The HGS asymmetry ratio was calculated as HGS nondominant hand/HGS dominant hand, using the highest HGS values. We determined asymmetry according to the 10% rule, in which participants with an HGS ratio <0.90 (10%) were considered to have dominant asymmetric HGS, whereas those with an HGS ratio >1.10 (10%) were classified as having nondominant asymmetric HGS(19). We considered patients with either dominant or nondominant HGS asymmetry as having HGS asymmetry.

**Statistical analysis**

We used Stata version 16.0 (StataCorp, TX, US) for data processing. Descriptive statistics were used to determine the demographic and clinical characteristics of the participants. Categorical variables were presented as frequencies and percentages. We performed the first bivariate analysis using the chi-square test to evaluate the presence of significant differences.
between HGS asymmetry and categorical variables. The second bivariate analysis evaluated the presence of HGS asymmetry and potential influencing factors stratified by sex.

Finally, we applied individual Poisson regression models and robust variance to assess the association between each potential influencing factor and HGS asymmetry. Crude prevalence ratios (cPR) and adjusted prevalence ratios (aPR) were calculated for the bivariate and multivariate analyses. In addition, we adjusted these models for age, sex, comorbidities, body mass index, calf circumference, PASE score, SPPB scale score, Lawton index, and Functional Reach Test score. Polypharmacy was excluded from the multivariate analyses due to multicollinearity with multimorbidity, which was evaluated using the variance inflation factor. All models were presented with their respective 95% confidence intervals (95% CIs), and p <0.05 was considered significant.

**Ethical considerations**

This study was approved by the Ethics Committee of the Naval Medical Center, Callao, Peru. Information from a secondary database was evaluated using codes for each participant to maintain the confidentiality of all included patients.

**Results**

Our study included a total of 1468 patients, of whom 863 (58.79%) were male, and 816 (55.59%) were aged 60–79 years. The prevalence of asymmetry was 74.66% (Table 1).

In the asymmetry group, 640 (74.16%) patients were male, 1031 (75.37%) had multimorbidity, and 280 (67.15%) used ≥5 drugs. The asymmetric group showed a higher proportion of comorbidities, reduced calf muscle mass, and polypharmacy than the symmetric group did (all P < 0.05) (Table 2).

The multivariable analyses revealed that HGS asymmetry was independently associated with reduced calf muscle mass (cPR = 1.08, 95% CI = 1.01–1.16), polypharmacy (cPR = 0.86, 95% CI = 0.80–0.93), and multimorbidity (cPR = 1.16, 95% CI = 1.01–1.34). After adjusting for age, sex, multimorbidity, body mass index, calf circumference, PASE score, SPPB scale score, Lawton index and Functional Reach Test score, reduced muscle mass measured by calf circumference (aPR = 1.08, 95% CI = 1.01–1.15), fall risk measured by Functional Reach Test (aPR = 1.08, 95% CI = 1.02–1.16), and functional impairment measured by Lawton index (aPR = 0.92, 95% CI = 0.84–0.99) were associated with HGS asymmetry (Table 3).

In the male group with asymmetry, 601 (75.03%) had multimorbidity, 438 (76.44%) had reduced muscle mass, 163 (64.43%) had polypharmacy, 218 (68.99%) had functional impairment, and 196 (80.00%) were at risk of falling. The male group with asymmetry showed a higher proportion of comorbidities, reduced muscle mass, polypharmacy, and functional impairment than the male group with symmetry did (all P < 0.05). In contrast, the female group with asymmetry showed a higher fall risk than the female group without
asymmetry did \( P < 0.05 \) (Table 4). Supplementary Table 1 presents the HGS values in the dominant and nondominant hands according to the sarcopenic variables (SPPB scale score and calf circumference).

**Discussion**

This cross-sectional study of older Peruvian adults presents three main findings. First, reduced muscle mass, fall risk, and functional impairment were independently associated with HGS asymmetry. Second, the male population with asymmetry showed a higher proportion of reduced muscle mass, multimorbidity, polypharmacy, and functional impairment, compared with those without asymmetry. Third, the female population with asymmetry showed a higher fall risk, compared with those without asymmetry.

In contrast to similar studies, we observed a higher prevalence of HGS asymmetry (51.7%, 45.2%, and 74.6%, respectively). Moreover, in our study, the prevalence of HGS asymmetry was higher in men (74.1%) compared with those reported in similar studies (38.3% and 47.8%)\(^{20,21}\). This difference could be explained by the inclusion of a Peruvian military-based population, in which more than half of the study participants were men and 75.1% were considered pre-frail and frail\(^{10}\).

Reduced muscle mass is associated with HGS asymmetry. This specific measure is important because a previous study demonstrated that frailty increases as calf muscle mass decreases\(^{22,23}\). As HGS asymmetry improves evaluations of muscle strength as part of the frailty criteria, our findings can lead to further evaluation and suggest that reduced calf muscle mass may be an alternative criterion of frailty\(^{8,24}\). In addition, we observed an association between HGS asymmetry and fall risk. McGrath et al. reported that patients with HGS asymmetry have increased risks of recurrent falls and fractures\(^{25}\). Furthermore, Go et al. showed a higher proportion of HGS asymmetry in the group with falls than in the group without falls\(^{26}\). This finding is explained by the links among neuromuscular function, physical performance, and the disabling process\(^{27}\). Neuromuscular function deficiencies precede poor physical performance and mark disability onset\(^{27}\). As individuals progress to advanced stages of the disabling process, their reduced physical performance limits the effectiveness of fall prevention interventions\(^{28}\). Low neuromuscular function, measured by indicators, such as HGS and functional asymmetries, could represent disability\(^{29}\).

Furthermore, according to the Lawton index, functional impairment, which measures the ability to perform IADLs, was also associated with HGS asymmetry. Similar to our results, Mahoney et al. reported a greater likelihood of IADL limitations, such as transfer and toileting in individuals with HGS asymmetry\(^{21}\). HGS asymmetry reflects reduced neural and motor system function, indicating a decline in overall neuromuscular function\(^{30}\). This deterioration leads to physical and functional limitations, thereby increasing the impairment of IADLs\(^{31}\). Moreover, the link between hand and brain hemisphere dominance suggests that differences in HGS between hands may reflect lower functioning in a specific brain hemisphere\(^{31,32}\).
A higher proportion of male patients with HGS asymmetry showed reduced muscle mass. HGS is a simple and accessible method to assess muscle strength because of its low cost and association with leg strength; moreover, this measure is also associated with sarcopenia as it reflects decreased muscle strength(33,34). Men have greater strength and muscle mass than women do; however, this difference decreases with age (35). Because the sample in this study was composed of Navy veterans (older adults), their strength decrement was greater than that of the general population.

We observed an independent association between multimorbidity and HGS asymmetry and polypharmacy among men. Men are more likely to have heart disease, stroke, and diabetes, compared with women; moreover, most men do not attend regular check-ups, and veterans report more morbidities(36–38). Moreover, in chronic kidney disease, muscle strength decreases due to diabetic neuropathy, myopathy in arterial insufficiency, or skeletal muscle impairment(39–41). In addition, older adults with several diseases often consume multiple drugs, some of which can cause neuropathy or myopathy(42,43). The sum of the above effects could lead to more adult men presenting with muscular or neurological damage, and therefore, HGS asymmetry. Parker et al. reported that HGS asymmetry is a predictor of IADL limitations, whereas Mahoney et al. observed an association between ADL and HGS asymmetry in both sexes(21,44). We observed this association only in men, which may be due to the composition of the sample and comorbidities.

In contrast, the female population with HGS asymmetry in this study presented a higher risk of falls. McGrath et al. reported that for each 0.1 increase in the HGS asymmetry ratio, older adults were 26% more likely to fall in the future, with an increase in these odds as the degree of asymmetry increased (25). Similar findings were reported by Go et al. in an older Korean population, with an odds ratio of 1.89 for falls in a group with HGS asymmetry(26). In the study by Yang et al. in a Taiwanese population, weakness and reduced exercise duration were observed in a fall group, which also included a higher proportion of women(45). Falls can be attributed not only to musculoskeletal system alterations, as in the case of sarcopenia or osteoarthritis, but also to the complexity of the neuronal component, including functional deficiencies and disparity in the activation in brain hemispheres, which may influence brain networks related to cognitive function, as these effects are associated with limitations in ADLs(21,30,46–48). Therefore, further studies of the relationship between neuroanatomical changes and HGS asymmetry are required.

Our study has some limitations. First, as this was a cross-sectional study, we could not evaluate the causality between HGS asymmetry and associated factors; thus, a follow-up study is required to confirm our results. Second, HGS asymmetry is a new concept and has been analyzed using a previous database. However, as the measurement was performed using a standardized procedure, our results were not affected. Third, we did not exclude patients with neurological diseases or a history of upper-body surgery that could influence HGS asymmetry. Fourth, using a database from 2010 to 2016 may have included a population with access to technology and a different lifestyle, as this was before the coronavirus disease pandemic. Fifth, the external validity was limited because the results were obtained from a
single center. Finally, we could not compare HGS and toe grip strength with the potential influencing variables as the latter is also a predictor of functional limitations in older adults (49–51). Despite these limitations, this is the first Latin American study to assess factors influencing HGS asymmetry in an older adult population.

In summary, the results of this study demonstrated the association of HGS asymmetry with reduced muscle mass, fall risk, and functional impairment in older adults. Furthermore, HGS asymmetry was differentially related to multimorbidity, reduced muscle mass, functional impairment, and polypharmacy only in men. We also observed a significant association with an increased risk of falls among women. Our findings suggest that the evaluation, management, and rehabilitation of older adults should be comprehensive and specific to the damaged organs or limbs. HGS asymmetry should be measured in conjunction with other geriatric assessments to evaluate health outcomes in older adults. Moreover, these findings may inform a more accurate approach for patients, improve health promotion and prevention, and determine specific interventions aimed at preserving muscle strength to curb functional limitations in older adults. These results also reveal the opportunity for interventions beyond biomarkers or yes/no disease diagnosis.

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Data availability statement
Data are available at the following link: https://osf.io/df7tn/files/osfstorage?view_only=