

ORIGINAL ARTICLE

Hand Grip Strength Differences in Geriatric Subjects with and without Hand Diseases

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Objective: The aim of this study was to investigate the impact of untreated hand diseases on hand grip strength, a value that is commonly used as a diagnostic parameter for sarcopenia and frailty in geriatric populations. We hypothesized that individuals with untreated hand diseases would have lower grip strength than those without hand diseases. **Methods:** A total of 240 individuals aged at least 65 years were recruited and divided into two groups based on the presence or absence of typical hand diseases. Grip strength was compared between the two groups separately for men and women using a *t*-test, with each group consisting of 60 women or 60 men. **Results:** Both women and men in the hand disease group exhibited significantly lower grip strength than those in the control group. **Conclusions:** These findings suggest that untreated hand diseases have a negative impact on grip strength, and this may introduce bias in the screening or diagnosis of sarcopenia and frailty. It is essential to consider the presence of hand diseases when measuring hand grip strength in older adults.

Key Words: sarcopenia; frailty; hand strength; geriatric; hand

INTRODUCTION

Hand grip strength is a widely used and accessible test that can be measured using a hand dynamometer.¹⁾ This quantitative evaluation is routinely used in hospital practice and specialty clinical settings and is incorporated into many assessment tools.^{2,3)} As the global population ages, the prevalence of sarcopenia and frailty is increasing worldwide. Sarcopenia refers to the age-associated loss of skeletal muscle mass and function, whereas frailty is a physiological state marked by the deregulation of multiple systems in an aging organism.⁴⁻¹⁴⁾ Both conditions can have adverse health outcomes, and hand grip strength is used as a diagnostic or screening tool to detect low skeletal muscle strength resulting from sarcopenia and/or frailty.^{2,15-17)}

However, the presence of hand diseases, such as osteoarthritis, tenosynovitis, and entrapment syndromes are common in the geriatric population and can affect grip strength

measurement. The influence of comorbid hand diseases on grip strength and its implications for accurately assessing overall skeletal muscle strength in the context of sarcopenia and frailty have not been investigated in detail. The aim of this study was to investigate the differences in grip strength between geriatric individuals with and without hand diseases and to explore potential limitations in using hand grip strength to represent the general skeletal muscle strength in the presence of hand diseases.

MATERIALS AND METHODS

This prospective, single-center, cross-sectional study was conducted from January 2020 to December 2021. The study adhered to ethical guidelines based on the World Medical Association Declaration of Helsinki and obtained approval from the Ethics Committee at NTT Medical Center Tokyo (No. 19-391).

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Adult candidates aged at least 65 years were consecutively recruited without any selection, skipping, or excluded individuals. The purpose of the study was explained to each participant, and their age, sex, height, weight, hand dominance, major comorbidities, and the presence of any hand injury or related pathology were recorded. Written informed consent was obtained from all participants, ensuring that they were fully informed about the study's objectives, procedures, and potential risks and benefits; all subjects voluntarily agreed to participate.

Two groups were compared in this study. The first group comprised untreated patients visiting the hand clinic who were diagnosed with typical non-traumatic hand diseases by board-certified hand surgeons. These hand diseases included entrapment syndrome (carpal tunnel syndrome and/or cubital tunnel syndrome), trigger finger (stenosing flexor tenosynovitis), and osteoarthritis affecting the joints in the hand, such as trapezio-metacarpal arthritis, Heberden nodules, and Bouchard nodules. The second group consisted of volunteers with no prior history of hand diseases. These individuals confirmed that they were not experiencing symptoms such as pain, tenderness, weakness, numbness, or tingling in bilateral upper extremities at the time of the study. In addition, participants in both groups had no history of upper extremity trauma, cervical spine disease, cerebrovascular diseases, or inflammatory diseases such as rheumatoid arthritis. Informed consent was obtained from all subjects before their participation in the study commenced.

The primary endpoint for this study was to assess the differences in grip strength between geriatric cohorts with or without hand diseases; analysis was done separately for women and men. The Jamar dynamometer, which is a valid and reliable instrument, was used to measure hand grip strength.¹⁸⁾ Grip strength was measured using newly-prepared Jamar isometric hand dynamometers (Saehan Corporation, DHD-3, Gyeongnam, Korea), which utilize a sealed hydraulic measurement system with a stated measurement range of 0–90 kg. The accuracy of the dynamometers is $\pm 1\%$ of the full scale, and they come with a Certificate of Calibration provided by B&L Engineering (Santa Ana, CA, USA).^{19,20)} The dynamometers were routinely calibrated for each participant to ensure accuracy and consistency of the measurements. The posture of the participants was standardized according to the guidelines of the American Society of Hand Therapy. Participants were seated with their shoulders neutrally rotated, the elbow flexed at 90° , the forearm in a neutral position, and the wrist between 0° and 30° of dorsiflexion.^{21,22)} The strongest grip measurement usually occurs

when using the second, third, or fourth handle position.²³⁾ The combined efforts of the intrinsic and extrinsic muscles were evaluated at levels 1, 2, and 3.²⁴⁾ Because the second handle position showed the best results in previous studies, the second handle position was used for all participants.^{25–27)} Participants were instructed to perform three maximum-effort isometric contractions alternately with each hand, and the readings were recorded in kilograms. According to the Asian Working Group for Sarcopenia (AWGS) 2019 Guidelines, it is recommended to use the best performance of either two or three trials.¹⁶⁾ Therefore, the maximal value of three measurements was chosen for each hand. Given the potential differences in grip strength between the dominant and non-dominant hands, we analyzed the average values of the right and left maximal measurements. This decision was based on the recognition that hand diseases often impact both hands and can manifest randomly in either the dominant or non-dominant hand, even in cases where the disease is unilateral. In cases of unilateral hand disease, significant discrepancies in grip strength can exist between the affected and unaffected hands. Therefore, when making comparisons with the control group, we considered it appropriate to utilize the average maximal grip strength of the right and left hands combined. This approach allowed us to account for potential differences caused by unilateral hand diseases. By assessing the average grip strength, our aim was to encompass the overall hand strength status within our study population, considering the potential bilateral and random occurrence of hand diseases. This approach provided a more comprehensive understanding of the relationship between hand diseases and grip strength in our analysis.

STATISTICAL METHODS

Continuous variables in the two groups were compared using a two-sample unpaired *t*-test. By assuming a standard deviation of 5%, a power analysis indicated that a total sample size of 118 participants (59 per group) would provide 90% statistical power to detect a significant difference between groups using the two-sample unpaired *t*-test. With separate analyses for women and men, 236 participants would allow 59 members per group.

The Charlson comorbidity index and scores were calculated based on the documented comorbid conditions for each group.²⁸⁾ The ages, heights, body weights, and Charlson scores of the groups with or without untreated non-traumatic hand diseases were compared using the Wilcoxon-Mann-Whitney test to determine any significant

differences between the hand-disease group and the control group. The hand dominance and the number of participants with maximal grip strength for either the right or left hand below the AWGS cut-off value for low muscle strength were compared using Pearson's chi-square test. Additionally, one-way analysis of variance was used to compare the numbers of participants in the hand disease subgroups.

A significance threshold of $P < 0.05$ was employed to determine statistical significance. Separate analyses were performed for women and men. IBM SPSS Statistics version 24.0 was utilized for all data analysis procedures.

RESULTS

Female participants in the hand-disease group had an average maximal grip strength of the left and right hand combined of 15.36 kg, whereas, for those in the control group, the value was 18.95 kg. Male participants in the hand-disease group had an average grip strength of 26.47 kg, compared to 31.99 kg in the control group. There was a significant difference in grip strength between the groups for both women ($P=0.001$) and men ($P=0.003$).

In the hand-disease group, 29 women and 28 men demonstrated maximal grip strength below the AWGS threshold for low muscle strength, whereas, in the control group, 10 women and 11 men were below the threshold ($P=0.000$ for women, $P=0.001$ for men).

There was no statistically significant difference between women and men concerning the variability of hand diseases ($P=0.47$). In total, 23 women and 24 men had overlapping hand diseases across two or three subgroups. Moreover, 27 women and 27 men experienced hand diseases affecting both hands.

The median ages in the control group were 76.0 years for women and 71.0 years for men. In the hand-disease group the median ages were 74.0 years for women and 73.0 years for men. There were no significant differences in ages between

the groups for either women ($P=0.38$) or men ($P=0.057$).

The average heights and weights in the control group were 151.7 cm and 55.2 kg for women and 165.0 cm and 67.3 kg for men. In the hand-disease group, these values were 151.9 cm and 54.3 kg for women and 164.7 cm and 65.2 kg for men. There were no significant differences in heights or weights between the groups for either women ($P=0.73$ for height, $P=0.60$ for weight) or men ($P=0.32$ for height, $P=0.20$ for weight).

The average Charlson comorbidity index scores were 4.0 for women and 3.6 for men in the control group, and 3.8 for both women and men in the hand-disease group. There were no significant differences in Charlson scores between the groups for either women ($P=0.30$) or men ($P=0.076$).

In the control group, 55 women and 56 men were right hand dominant, whereas in the hand-disease group, 57 women and 54 men were right hand dominant. There were no significant differences in handedness between the groups for either women ($P=0.46$) or men ($P=0.51$).

Please refer to **Table 1** for detailed participant characteristics, **Table 2** for hand disease subgroups, and **Table 3** for average grip strength and cut-off values based on AWGS 2019 Guidelines. Additionally, **Table 4** provides information on the number of participants with maximal grip strength below the cut-off value, along with average maximal grip strength values.

DISCUSSION

In this study, we examined the impact of hand conditions on grip strength and its potential association with sarcopenia or frailty. Our results show significantly lower grip strength in both female and male participants with hand diseases compared to the control group. These results indicate that hand conditions can directly contribute to a decrease in grip strength. It is also important to acknowledge that hand diseases alone do not typically lead to frailty or sarcopenia,

Table 1. Participants' characteristics

Group	Age (median: years)	Height (average: cm)	Weight (average: kg)	Charlson Score (average)	RHD (n)
Female control group (n=60)	76.0	151.7	55.2	4.0	55
Women with hand disease (n=60)	74.0	151.9	54.3	3.8	57
P	0.38	0.73	0.60	0.30	0.46
Male control group (n=60)	71.0	165.0	67.3	3.6	56
Men with hand disease (n=60)	73.0	164.7	65.2	3.8	54
P	0.057	0.32	0.20	0.076	0.51

RHD, right-hand dominance.

Table 2. Details of hand diseases

Hand Disease	Women (n)	Men (n)
Entrapment syndrome	27	29
Trigger finger	28	27
Osteoarthritis	32	27
Participants with 2 or 3 diseases	23	24
Participants with bilateral involvement	27	27

Some participants had more than one hand disease and/or bilateral involvement.

Table 3. AWGS cut-off values for low muscle strength and average grip strength

	AWGS Cut-off (kg)	Hand Disease Group (kg)	Control Group (kg)	P
Women	18	15.36	18.95	0.001
Men	28	26.47	31.99	0.003

Table 4. The number of participants with maximal grip strength below the AWGS cut-off for low muscle strength

	Hand Disease Group (n) [Avg (kg)]	Control Group (n) [Avg (kg)]	P
Women	29 [13.8]	10 [14.8]	0.000
Men	28 [23.6]	11 [22.6]	0.001

Avg, average maximal grip strength.

which are complex conditions influenced by a range of factors.

The AWGS defined low muscle strength as grip strength below 18 kg for women and below 28 kg for men, whereas the European Working Group on Sarcopenia in Older People 2 (EWGSOP2) set the low strength cut-off points as below 16 kg for women and below 27 kg for men.^{2,10} Interestingly, we found that only individuals with symptomatic hand diseases met both criteria for low muscle strength. Furthermore, even when applying the maximal grip strength from either the right or left hands, the hand-disease group had a significantly higher proportion of individuals with lower grip strength below the AWGS criteria compared with the control group (**Table 4**).

Because hand grip strength is moderately associated with strength in other parts of the body and is a simple test to perform, it is a commonly used measure of overall skeletal muscle strength.² Moreover, grip strength has a stronger association with frailty markers than with chronological age. This suggests that grip strength can serve as a valuable indicator of overall physical function and frailty status, regardless of age.^{29,30} However, untreated hand diseases can negatively affect grip strength, potentially leading to a bias in screening

for, or diagnosing, frailty or sarcopenia. Therefore, it is crucial to carefully consider an individual's medical history and current upper extremity symptoms before conducting grip strength measurements. In cases where there is uncertainty regarding the presence of hand disease, it is recommended to avoid testing the affected hand. Nevertheless, it is crucial to consider the frequent occurrence of bilateral hand disease, as observed in this study, with nearly half of subjects affected in both hands. In such cases, performance-based tests of physical function, such as walking velocity or lower limb strength measurements, can be used instead of grip strength.^{31,32} Additionally, measuring the appendicular or total muscle mass may be an alternative method for diagnosing sarcopenia.³³

LIMITATIONS

Limitations of this study include the use of a fixed handle position on the Jamar hand dynamometer, which may not have captured the maximal grip strength in some cases. However, because no specific hand feature was identified that predicted the optimal handle position, it was deemed reasonable to use the same handle position (setting 2) for all patients, thereby simplifying the measurement process.

Another limitation is that the study did not measure appendicular skeletal muscle mass or physical performance for each participant. This information could have provided a more comprehensive understanding of the relationship between grip strength and the quantity or quality of muscle in diagnosing sarcopenia. Future studies could consider incorporating measures of appendicular skeletal muscle mass and physical performance to enhance the understanding of grip strength and its relationship to sarcopenia.

CONCLUSION

Based on the results of this study, in both female and male populations, grip strength is significantly lower in geriatric patients with hand diseases than in those without hand diseases. This suggests that the presence of hand diseases may pose challenges to accurately measuring grip strength. Therefore, hand status should be taken into account when measuring grip strength for screening or diagnosing frailty or sarcopenia in the geriatric population.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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