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Identification of Dynapenia in Older Adults Through the Use of Grip Strength T-Scores

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Abstract

Objective—To generate reference values and t-scores (1.0 to 2.5 standard deviations below average) for grip strength for healthy young adults and to examine the utility of t-scores from this group for the identification of dynapenia in older adults.

Design—Secondary analysis of cross-sectional grip strength data from the NIH Toolbox norming sample.

Setting—Population-based general community sample.

Participants—Community dwelling adults, between the ages 20 and 40 years (n=558); and 60 to 85 years (n=390)

Main Outcomes Measures—Grip strength measured with a Jamar plus dynamometer.

Results—Maximum grip strengths were consistent over the 20–40 year age span. For men they were 108.0 lbs (S.D. 22.6). For women, they were 65.8 lbs (S.D. 14.6) Comparison of older participant grip strengths to those of the younger reference group revealed (depending on age strata) that 46.2–87.1% of older men and 50.0–82.4% of older women could be designated as dynapenic on the basis of t-scores.

Conclusion—The use of reference value t-scores from younger adults is a promising method for determining dynapenia in older adults.

MESH Terms

Hand strength; muscle weakness; aged; hand grip dynamometer; measurement

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INTRODUCTION

Dynapenia, a loss of muscle strength in older adults not attributable to primary neurologic or muscular disease, has untoward consequences for the performance of daily activities and survival.[1,2] While there are numerous alternatives for objective quantification of muscle strength in older adults, dynamometric measures of grip and knee extension strength predominate.[3,4] Of these 2 options, hand-grip dynamometry (HGD) has the advantage in terms of affordability, portability, simplicity, and time efficiency.

If HGD is to be useful in identifying losses in muscle strength among older adults, measurements obtained by the procedure must be put into perspective. Gender- and age-matched normative values are available and are useful in this regard.[5,6] Criterion grip strength cut-points for upper limb function,[7] mobilty,[8] post-operative complications,[9] and mortality[10] are also available and are informative. What has been advocated only rarely as a source of perspective are grip strength values obtained from young healthy adults.[11,12] This contrasts with the widespread use of values obtained from young individuals in the examination of bone mass.[13] In such examinations older adults are assigned t-scores based on where their measures fall in standard deviation units below measures obtained from average 30 year olds. Individuals with t-scores between 1.0 and 2.5 below average are considered osteopenic.

We believe the use of grip strength t-scores is warranted, as older adults may have diminished strength in spite of having strength comparable to their peers or unremarkable relative to criterion values. Consequently, we undertook this study to generate reference values for grip strength for healthy young adults. Relative to these values we determined t-scores (1.0 to 2.5 standard deviations below average) to which older adults could be contrasted. We then examined the utility of the t-scores for identifying dynapenia in a sample of older adults.

METHODS

The study was part of the National Institutes of Health (NIH) Toolbox Assessment for Neurological and Behavioral Assessment, a project designed to develop a comprehensive and integrated set of performance-based measures of cognitive, motor, and sensory function and emotional health for people ages 3 to 85 years.[14] Following an extensive instrument-by-instrument validation process, the NIH Toolbox team conducted a large national standardization study in a sample of 4859 people in 10 geographically diverse sites located in the continental United States.[15] The project was approved by the NorthShore University Health System Institutional Review Board.

Participants

All participants from the NIH Toolbox standardization study provided written consent after being informed about the study's purpose and procedures. Of the 4859 individuals consenting, 293 were missing grip strength data and were excluded. The recorded values of 90 participants were deemed to be outliers or invalid (≥2.5 standard deviations from mean or ≥ 25% different between sides). Of the remaining 4476 participants, 558 (152 men and 406

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women) were between ages 20 and 40 years, an age range of relatively young adults shown in earlier research to produce the greatest magnitudes of grip strength;[12,16] 390 participants (233 men and 266 women) were age 60 to 85 years.

Procedures

Sex, ethnicity, hand dominance, age, height, and weight were determined by self-report as part of a standardized intake questionnaire. In accordance with the recommendations of the American Society of Hand Therapists, grip strength was measured with a Jamar dynamometer in its second handle position while participants were seated with the arms by their sides and elbows flexed 90 degrees.[17] After a sub-maximal practice trial with each hand, a single maximum measure was obtained from each hand. The strongest value, regardless of hand, was retained for analysis. All measures were administered by non-clinical research administrators who had an intensive 3-day Toolbox training and certification process.

Analysis

The Statistical Package for the Social Sciences (SPSS 21.0) was used for all analysis. Before consolidating data and calculating descriptive statistics for the participants 20 to 40 years, scatterplots were examined and a general linear model was used to investigate the effects of gender and age on grip strength. The model (adjusted R squared = .539) confirmed that gender had a significant effect on grip force (F= 535.2, $P<.0001$) but that age (ie, 20, 21, 22, 23…40 years) did not have a significant effect (F=.809, $P= .704$). There was no significant interaction between gender and age (F= .886, $P= .606$). Consequently, descriptive grip strength data were consolidated for ages 20 through 40 but presented separately for men and women. T-scores were calculated for the strongest grip (regardless of side) of participants by subtracting 1.0, 1.5, 2.0, and 2.5 standard deviations from the mean. For participants aged 60 to 85 years, grip strength values were summarized for gender and age strata. The number and percentage of participants with dynapenia, as indicated by negative T-scores, was determined.

RESULTS

The sample was predominantly women (72.8% among 20–40 year olds; 54.4% among 60–85 year olds), white (74.2–83.8%), and right-handed (93.4–96.2%). On average, the sample was overweight [BMI 28.4 (S.D. 7) – 28.4 (S.D. 5.6)]. Consolidated grip strength values from 20 to 40 year olds as well as t-scores derived from the values are listed in Table 1. To facilitate use, the summary data in the table are presented in pounds and kilograms. Table 2 lists grip strength values from 60 to 85 year olds as well as the number and percentage of these older adults with t-scores of −1.0 to −2.5. Of the older men tested 46.2 to 87.1 percent had t-scores of 1.0 or below and could be considered dynapenic. For the older women tested, 50.0 to 82.4 percent could be designated as dynapenic based on t-scores of 1.0 or below.

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DISCUSSION

Considerable data are available for putting the grip strength of older individuals into perspective.[5–10] The use of grip strength t-scores by Cheung et al notwithstanding,[11,12] t-scores have not been used routinely to identify dynapenia in older adults. We do this by using data from the NIH Toolbox. As the study employed a population-based sample of individuals aged 3 to 85 years, we were able to calculate t-scores for relatively young healthy adults and then use the t-scores to identify older adults with age-related loss in grip strength. Based on grip strength values 1.0 or more standard deviations below the means of healthy young men and women, most (about 64%) of the older adults tested could be considered dynapenic.

It was not the specific purpose of this study to present normative values *per se* or to compare values with those previously reported by others. In fact, exact comparisons are not possible. Nevertheless, normative values for grip strength have been reported for both younger and older adults. Bohannon et al published a meta-analysis in which they consolidated grip strength values obtained from 20 to 49 year olds in several different studies.[16] Their values were slightly higher than those reported in this study for both men and women. For example, the mean for the right side of men in their meta-analysis was 116.8 pounds (95% CI 110.8–122.9), whereas the mean for the best side of men in our study was 108.0 pounds. In another meta-analysis, Bohannon et al used the same strata for older adults (e.g., men, 70–74 years) as in this study.[5] Again, the values in the meta-analysis were slightly higher than found in this study. For example, the mean for the right side of 70 to 74 year old women in their meta-analysis was 53.4 pounds (95% CI 45.6–61.3), whereas the mean for the best side of women in this study was 48.2 pounds. We cannot confidently explain the cause of the difference, but it may be a consequence of the NIH Toolbox study's use of a population-based sample. Many of the studies included in the meta-analyses used convenience samples.

This study did not examine the clinical importance of dynapenia using t-scores derived from younger adults. We do not know, for example, whether deficits relative to younger adults or impairments relative to age-matched peers are more informative as to status. We also do not know the predictive validity of the t-scores. Functional correlates of t-scores of 1.0 and below should be determined to place scores within a framework for interpretation. The value of interventions for older adults with dynapenia identified by HGD remains to be established.

Study Limitations

In addition to points already made, there are limitations to this study. First, while it involved a population-based sample, it was limited to the United States. Consequently the t-scores may not generalize to some other locations outside the United States. Second, the age range selected for generating t-scores may not be optimum. Although the age range of adults used to calculate t-scores was within the 20–49 year range described by Bohannon et al[16] and included the 30–39 range used by Cheung et al,[11,12] it may have been too restrictive. Third, we only looked at grip strength as an indicator of dynapenia. While grip strength is related to lower limb strength in apparently healthy adults,[3] the decline in strength accompanying aging can differ between muscle groups.[18] Fourth, we used a Jamar dynamometer in its

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second handle position to obtain a single criterion measure- strongest grip strength. Other instruments and procedures may yield different results. The strongest grip strength does not allow specific side comparisons (e.g., left versus right or dominant versus nondominant). We believe, nevertheless, based on the definition of dynapenia, that use of the best is most warranted. It helps to obviate problems resulting from neurologic or musculoskeletal disorders with unilateral effects. Finally, we did not adjust grip strength values for body weight or BMI. Although that is sometimes done,[12,19] we found in our analysis (not reported) that anthropometric variables made much difference in grip strength measures.

CONCLUSION

There is no established criterion for assessment of age-related losses of muscle strength (dynapenia). We propose the use of reference grip strength t-scores as a promising method for establishing dynapenia in older adults.

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Abbreviations

BMI	Body Mass Index
HGD	Hand Grip Dynamometry
NIH	National Institutes of Health
SPSS	Statistical Package for the Social Sciences

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Table 1

Strongest Grip Values and T- Scores Derived from Men and Women aged 20 to 40 Years

Gender (n)	Units	Mean (SD)	−1.0 SD	−1.5 SD	−2.0 SD	−2.5 SD
Men (152)	Pounds	108.0 (22.6)	85.4	74.0	62.7	51.4
	Kilograms	49.0 (10.3)	38.7	33.6	28.4	23.2
Women (406)	Pounds	65.8 (14.6)	51.2	43.9	36.6	29.3
	Kilograms	29.8 (6.6)	23.2	19.9	16.6	13.3

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Table 2

Strongest Grip Values and T-Scores for Men and Women 60 to 85 Years

Gender	Age Group Range (n)	Pounds Mean(SD)	Kilograms Mean (SD)	−1.0 N (%)	−1.5 N (%)	−2.0 N (%)	−2.5 N (%)
Men	60–64 (38)	84.3 (23.6)	38.3 (10.7)	8 (21.1)	2 (5.3)	3 (7.9)	5 (13.2)
	65–69 (26)	82.8 (21.5)	37.6 (9.8)	5 (19.2)	3(11.5)	1 (3.8)	3 (11.5)
	70–74 (42)	76.4 (22.0)	34.7 (10.0)	12 (28.6)	5 (11.9)	2 (4.8)	6 (14.3)
	75–79 (26)	75.1 (22.9)	34.1 (10.4)	8 (30.8)	4 (15.4)	4 (15.4)	3 (11.5)
	80–85 (46)	62.8 (20.9)	28.5 (9.5)	7 (15.2)	12(26.1)	8 (17.4)	13 (28.3)
Women	60–64 (58)	53.0 (14.1)	24.0 (6.4)	14 (24.1)	9 (15.5)	4 (6.9)	2 (3.4)
	65–69 (33)	51.0 (15.8)	23.1 (7.2)	10 (30.3)	4 (12.1)	2 (6.1)	2 (6.1)
	70–74 (46)	48.2 (11.9)	21.8 (5.4)	13 (28.3)	7 (15.2)	6 (13.0)	1 (2.2)
	75–79 (24)	44.3 (13.8)	20.1 (6.3)	5 (20.8)	6 (25.0)	3 (12.5)	3 (12.5)
	80–85 (51)	45.3 (8.9)	20.5 (4.1)	13 (25.5)	25 (49.0)	2 (3.9)	2 (3.9)