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ORIGINAL RESEARCH

HAND GRIP STRENGTH IN SENIOR ATHLETES: NORMATIVE DATA AND COMMUNITY-DWELLING COMPARISONS

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ABSTRACT

Background: Hand grip strength is supported as a valid physical capacity measure in older adults. Normative values for community-dwelling older adult hand grip strength were recently updated. With the majority of community-dwelling older adults identified as sedentary, it is likely that current norms represent a group that is relatively inactive. A sub-population of senior athletes who actively engage in exercise and competitive sport have consistently demonstrated superior performance on measures of physical capacity when compared to the general population. Normative values for hand grip strength have not been established for this unique group of aging athletes.

Purpose: To establish hand grip strength norms for senior athletes and to compare these outcomes to available normative data in community-dwelling older adults.

Study Design: Cross-Sectional Study

Methods: Measures of hand grip strength were taken on 2,333 senior athletes registered to compete in the National Senior Games between 2011 and 2017. Findings were divided into age and gender categories consistent with community-dwelling norms. Student *t* tests were used to compare senior athlete means to community-dwelling norms. Cohen's *d* was calculated to estimate the effect size of each comparison.

Results: Normative values for senior athlete hand grip strength are reported in kilograms by age, gender and hand dominance. For each age and gender category tested, senior athletes demonstrate dominant hand grip strength that ranges from 8.6-11.1 kg higher for males and 5.5 to 8.9 kg higher for females (*p values* < .0001) than published community-dwelling norms. Non-dominant grip strengths were also significantly higher (*p values* < .0001). Effect sizes were medium to large (Cohen's *ds* = 0.44-1.5).

Conclusion: Senior athletes demonstrate hand grip strength that is significantly higher than their community-dwelling peers and more similar to a younger community-dwelling population. The population-specific norms presented here will assist health care providers in more accurately assessing this high-functioning subset of aging adults.

Levels of Evidence: 2b

Keywords: aging athlete, master's athlete, senior olympics, fitness screen, movement system

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Conflict of Interest Statement: Dr. Jordre previously held a position on the Board of Trustees for the National Senior Games Foundation, an unpaid role. The National Senior Games Foundation has since been dissolved. Dr. Schweinle has no conflicts of interest to declare.

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INTRODUCTION

Hand grip strength is a measure of physical capacity frequently used in the screening or examination of older adults. This simple measure has been shown to associate significantly with both upper and lower body strength.[1] Strength, as measured by hand grip, has been shown to decline more rapidly after age 45[2] and can be used in the diagnosis of sarcopenia[3] as well as the prediction of a multitude of health conditions. Hand grip strength is a useful indicator of potential declines in physical mobility,[4] cognitive status,[5] health-related quality of life,[6] general physical function[7] and mortality risk.[8-10] This measure has been touted as a more accurate predictor of mortality than measures of systolic blood pressure[8] and has been supported as a valuable "vital sign"[11] of health in aging adults. With the broad array of serious health implications associated with this measure, it becomes critical that scores are interpreted accurately and with attention to relevant normative populations.

Normative values were published recently for the community-dwelling adult population[12] and include grip strength norms for several age groups older than 50. These norms have appropriately updated the literature which had been lacking in this area. However, with significant evidence that the general population of older adults is inactive,[13] these normative values likely reflect a population that is largely sedentary and not engaged in regular or purposeful physical exercise. Unfortunately, a 2019 report by the Physical Activity Council revealed that the age group demonstrating the "largest gain in inactivity" was for those aged 65 and older.[14]

There is, however, a subset of the aging population who engages in regular exercise and intense sport competition on a regular basis. In 2017[15] more than 10,000 athletes aged 50 and over participated in the National Senior Games, a biennial event which has taken place regularly since 1987. This population is atypical, with self-reported volumes of cardiovascular exercise averaging four hours each week and strength training averaging one hour each week.[16] Non-exercising older adults have been found to remain sedentary for more than 60% of each day.[13] Past reports of senior athlete gait speed,[17] leg strength,[16] and balance measures[18] have consistently demonstrated the tendency for these older adults to perform well-beyond expected community-dwelling norms. When assessing the health of these athletes it is necessary to have norms that accurately reflect their physical capacity and potential range of abilities. A clinician who compares a competitive senior athlete to community-dwelling norms may encounter a ceiling effect and inadvertently overestimate their patient's results. This highly active population is likely engaged in more challenging daily activities which pose different health risks. Analyses of conditions under which healthy and active older adults fall, depicts falls that are more likely to occur with outdoor activity of a vigorous nature and come with an increased risk for serious injury.[19] These findings support the need for population-specific norms useful in the screening of this unique cohort in order to more accurately assess risks to their health.[19] The purpose of this study was to establish normative values for hand grip strength in competitive senior athletes, stratified by age and gender, and to compare these outcomes to current community-dwelling norms. It is hypothesized that these normative results will exceed those published for the community-dwelling population.

METHODS

For this observational cohort study, senior athletes who were registered to compete in the National Senior Games between 2011 and 2017 were recruited within the athlete village of the games. Each participant signed a written informed consent approved by the Institutional Review Board of the University of South Dakota prior to data collection. In order to participate, the senior athlete had to be (1) registered to compete in a National Senior Games event at the time of testing, and (2) at least 50 years of age during the year of competition. No other inclusion or exclusion criteria were applied. In order to register for the National Senior Games, all athletes participated in state games events and successfully qualified via place or time standards. The National Senior Games does not require any pre-participation screening, nor do they collect any health metrics on participating athletes. Sports represented by the athletes tested can be found in Table 1.

Participants included 2,333 senior athletes. Average age was 68.07 (SD 9.25) with a range of 50-100 years.

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Table 1. *National Senior Games Events.*

Archery	Racquetball
Badminton	Roadrace (5K, 10K)
Basketball	Shuffleboard
Bowling	Softball
Cycling	Swimming
Field Events Only	Table Tennis
Golf (with cart)	Tennis
Horseshoes	Track
Pickleball	Triathlon
Racewalking	Volleyball

Men accounted for 40.6% of the participants (N = 948), while women accounted for 59.4% (N = 1,385). Participants were queried to determine their current age, gender, exercise habits and competitive sport. Their hand grip strength was tested in a seated position with a Jamar hydraulic hand grip dynamometer (Performance Health Supply, Inc., Cedarburg, WI). The Jamar dynamometer has been shown to have high inter-rater ($r = 0.98$)[20] and test-retest ($r > 0.80$)[21] reliability and has been referred to as the gold standard for assessment of hand grip strength.[22] The hand grip setting was standardized to the second position on the device to allow for replication of the protocol used by the normative population.[12] Participant position was also identical[12] thus, participants kept their arm at their side with the elbow bent to 90 degrees, as shown in Figure 1. Grip testing was performed in an alternating fashion between the right and left sides for a total of three trials on each side. Participants were asked to squeeze maximally for 3-5 seconds and their results were recorded in kilograms (kg). The higher average of the two sides was assigned dominance. To stay as consistent as possible with the comparative normative group and to facilitate future clinical application, the second of the three grip trials was used for data analysis.

STATISTICAL METHODS

All analyses were performed using SAS version 9.4. Descriptive statistics were computed for normative tables and participant demographics. For comparisons, participant results were divided into the same age and gender groups as available comparative norms,[12] with the addition of one group for those over 85, which was not represented in the comparative study. Age groups were: 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-85 and 86+.

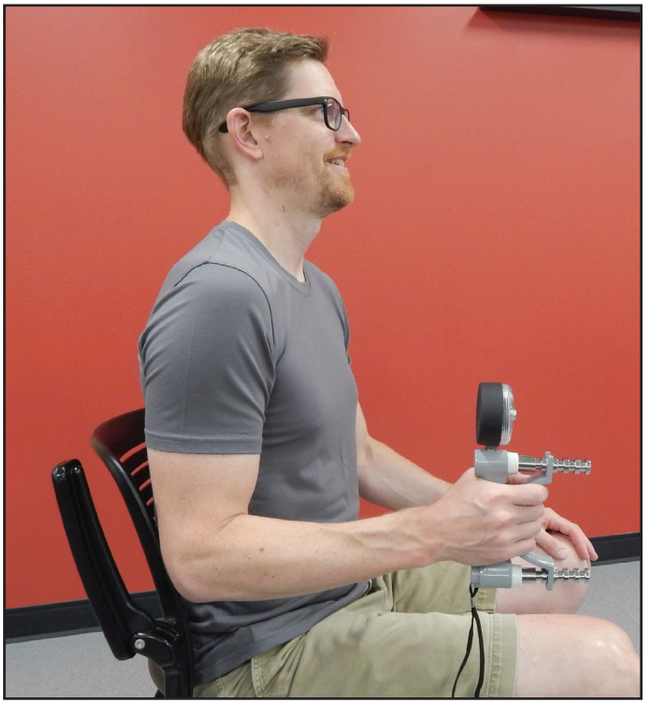

Figure 1. *Hand grip strength testing. Participants were seated with their arm by their side and elbow bent to 90 degrees. The hydraulic hand grip dynamometer was set at position 2 for all subjects.*

Student's *t* tests were used to compare mean hand grip in kg between the senior athlete mean and the community-dwelling published mean for men and women within each age group, with comparisons made for both dominant and non-dominant sides. Alpha was set at < 0.05. Cohen's *d* was calculated for effect size of all comparisons.

To support the use of the second grip trial for use in comparison purposes, an ANOVA was applied to the change scores between each of the three trials to determine any meaningful clinical difference between the trials. The suggested minimal clinically important difference for hand grip strength (5.0 to 6.5 kg)[23] was utilized for comparison. The differences between the three successive grips ranged from 0.12 kg to 0.61 kg, and thus supported the use of the second grip for purposes of comparison.

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RESULTS

Senior athletes reported 4.64 (SD 1.76) days of purposeful exercise each week with an average of 335 (SD = 261) minutes per week of cardiovascular exercise and 66 (SD = 127) minutes per week of strength training.

Table 2 displays the results of each age group by gender for dominant hand grip strength in kg and Table 3 displays non-dominant side results. In each age group, by each gender and for both dominant and non-dominant sides, senior athletes demonstrated significantly higher hand grip strength than published community-dwelling norms (*ps* < .0001). The effect size for these relationships ranged from medium to large with Cohen's *ds* ranging from .44-1.50. Male senior athlete dominant grip strength was 8.6-11.1 kg higher than community-dwelling norms while female athlete strength was 5.5-8.9 kg higher.

DISCUSSION

The higher hand grip strength scores found in this population of senior athletes are consistent with

Table 2. *Dominant normative hand grip strength of senior athletes with comparisons to community dwelling normative data*[12] *by gender and age.*

Male					
Age	**Population**	**N**	**Mean (kg)**	**SD**	**Cohen's *d***
50-54	Senior Athlete	52	52.9*	7.71	.975
	Community Dweller	46	44.0	10.3	
55-59	Senior Athlete	97	51.8*	8.84	1.15
	Community Dweller	27	40.7	10.4	
60-64	Senior Athlete	155	48.9*	9.25	1.07
	Community Dweller	33	38.4	10.3	
65-69	Senior Athlete	181	46.2*	7.72	1.02
	Community Dweller	22	36.8	10.5	
70-74	Senior Athlete	187	43.7*	8.03	1.06
	Community Dweller	39	34.7	9.0	
75-79	Senior Athlete	125	41.3*	8.34	.933
	Community Dweller	24	32.7	10.1	
80-85	Senior Athlete	97	38.9*	7.43	1.31
	Community Dweller	38	28.1	9.1	
86+	Senior Athlete	54	33.1	6.81	NA
	Community Dweller	NA	NA	NA	
Female					
Age	**Population**	**N**	**Mean (kg)**	**SD**	**Cohen's *d***
50-54	Senior Athlete	127	35.5*	5.6	1.22
	Community Dweller	65	28.2	6.3	
55-59	Senior Athlete	226	33.5*	5.6	1.42
	Community Dweller	30	25.1	6.2	
60-64	Senior Athlete	253	31.5*	5.13	1.35
	Community Dweller	58	23.6	6.5	
65-69	Senior Athlete	286	31.0*	6.57	1.36
	Community Dweller	29	22.1	6.6	
70-74	Senior Athlete	234	29.2*	5.26	1.48
	Community Dweller	43	21.5	5.1	
75-79	Senior Athlete	136	27.9*	5.07	1.50
	Community Dweller	17	19.6	6.0	
80-85	Senior Athlete	81	25.4*	6.54	.987
	Community Dweller	46	19.9	4.4	
86+	Senior Athlete	42	22.2	4.61	NA
	Community Dweller	NA	NA	NA	

*Student's *t* test was significant at $p<.0001$
kg= Kilograms
SD= Standard deviation

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Table 3. *Non-Dominant normative hand grip strength of senior athletes with comparisons to community dwelling normative data[12] by gender and age.*

Male					
Age	**Population**	**N**	**Mean (kg)**	**SD**	**Cohen's *d***
50-54	Senior Athlete	52	47.9*	7.34	.623
	Community Dweller	46	42.3	10.6	
55-59	Senior Athlete	97	46.9*	8.62	.919
	Community Dweller	27	38.5	9.6	
60-64	Senior Athlete	155	44.0*	9.03	.755
	Community Dweller	33	37.2	9.1	
65-69	Senior Athlete	181	41.5*	7.72	.672
	Community Dweller	22	35.4	10.3	
70-74	Senior Athlete	187	39.5*	8.37	.613
	Community Dweller	39	34.0	9.5	
75-79	Senior Athlete	124	36.9*	9.4	.688
	Community Dweller	24	30.3	9.9	
80-85	Senior Athlete	97	35.2*	7.58	.951
	Community Dweller	38	27.1	9.4	
86+	Senior Athlete	54	29.89	6.43	NA
	Community Dweller	NA	NA	NA	
Female					
Age	**Population**	**N**	**Mean (kg)**	**SD**	**Cohen's *d***
50-54	Senior Athlete	127	31.9*	5.35	.901
	Community Dweller	65	26.5	6.5	
55-59	Senior Athlete	223	30.0*	5.74	1.05
	Community Dweller	30	23.6	6.4	
60-64	Senior Athlete	250	28.2*	5.54	.900
	Community Dweller	58	22.9	6.3	
65-69	Senior Athlete	285	27.8*	6.02	1.08
	Community Dweller	29	21.0	6.6	
70-74	Senior Athlete	233	26.0*	5.05	1.09
	Community Dweller	43	20.2	5.5	
75-79	Senior Athlete	136	24.5*	4.88	1.08
	Community Dweller	17	18.7	5.8	
80-85	Senior Athlete	81	21.9*	6.91	.444
	Community Dweller	46	19.4	4.0	
86+	Senior Athlete	42	19.7	4.28	NA
	Community Dweller	NA	NA	NA	

*Student's *t* test was significant at $p<.0001$
kg= Kilograms
SD= Standard deviation

other findings of significantly elevated physical capacity in aging athletes.[16-18] The dominant hand grip strength of male senior athletes aged 80-85 was most closely aligned with the norm for community-dwelling adults aged 60-64. Similarly, female senior athletes aged 80-85 demonstrated a mean closer to community-dwelling females aged 55-59. This phenomenon of senior athletes manifesting greater physical capacity, or a younger functional age has been seen before. Jordre et al.[16] found senior athletes consistently exceeded general population norms on the Five Times Sit to Stand Test with senior athletes aged 80-89 scoring better than normative data from 60-69 year-old community dwellers. Glenn et al.[17] found significantly higher maximal gait speed in those who engaged in competitive sport, even when compared to older adults who exercised regularly. Athletes engaged in the World Masters Games[24] were found to have smaller waist circumferences, lower blood pressure and lower cholesterol than the general population. Collectively, these findings point to a population that may be at decreased risk for adverse health events. In fact, senior athletes have been found to enjoy a lower prevalence

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of cardiovascular disease and diabetes[25] and a significantly lower incidence of falls.[18] In light of the strong links already established between hand grip strength and health, it could be surmised that senior athletes enjoy superior physical health and may function more similarly to a younger population.

It is important to note that the differences reported here are not only statistically significant but are clinically meaningful as well. Richard Bohannon's[23] 2019 systematic review aimed to establish a minimal clinically important difference (MCID) associated with hand grip dynamometry. He reported difficulty in determining an exact MCID due to limited research in the area but suggested an initial range of 5.0-6.5 kg as meaningful, based on four studies of adults with varied diagnoses.[23] One study not included in Bohannon's review addressed MCID for hand grip dynamometry in a cohort more closely aligned with the participants in this study: healthy elderly women aged 60-89.[26] Those findings designated a value of only 2.69 kg as the MCID.[26] Thus, it could be that even smaller changes in grip strength are needed to demonstrate a difference in healthy older adults. When these values are compared to the large differences seen in this study the unique physical capacity of senior athletes is clearly supported.

Despite the stark differences seen with this population, these findings are consistent with others that demonstrate a gradual decline in hand grip strength with age[12,27,28] and findings that men consistently maintain higher grip scores than women.[12,27] In the general population, hand grip strengths of less than 30 kg for men or less than 20 kg for women are associated with sarcopenia.[3] Community-dwelling norms for both men and women fall into this range by the 80-85-year age group.[12] Senior athlete norms never drop into this range, even when considering the 86+ age group. Health care providers have grown accustomed to the typical decline seen in aging adults and many have not been exposed to this unique population. Thus, the results presented here will inform providers and prepare them for interactions with more active seniors.

Limitations & Future Research

The method utilized here for assigning hand dominance differed slightly from the comparative population.[12] Dominance was assigned based on strength rather than subjective handedness. However, past studies have consistently found greater strength on the dominant side[12,29,30] and current recommendations[30] suggest utilization of the highest score from all trials, regardless of hand. Thus, the assignment of dominance becomes less critical than the outcome of grip. The grip tables in this study should reflect maximal ability in this cohort and clinicians should refer to the dominant hand tables when interpreting maximum grip potential.

The observational nature of this study may speak to a self-selected population of high-functioning, motivated senior athletes as all senior athletes tested were volunteers. While the large number of senior athletes in this analysis should provide more confidence in these findings, the potential effects of self-selection bias cannot be ignored. Additionally, self-report exercise volumes may be inflated and could not be verified.

Consequently, more research needs to be performed with regard to the effects of training volume, training type, regular competition, sport choices and the effects that these factors have on habits of daily living as well as psychological variables and correlations. Further, research is needed to relate grip strength to other measures of fitness and health in this population to determine if this increased grip strength expression is indicative of actual health outcomes or if it could mask underlying health conditions.

CONCLUSIONS

Senior athletes, a population engaged in high volumes of purposeful exercise, demonstrate hand grip strength values that are distinctly higher than those reported for the community-dwelling population with statistically and clinically significant differences. Normative values presented in this article should be useful when assessing senior athletes or older adults engaged in similar volumes of exercise.

REFERENCES

1. Bohannon RW, Magasi SR, Bubela DJ, Wang YC, Gershon RC. Grip and knee extension muscle strength reflect a common construct among adults. *Muscle Nerve.* 2012;46(4):555-558.
2. Landi F, Calvani R, Tosato M, et al. Age-related variations of muscle mass, strength, and physical performance in community-dwellers: Results from the

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Milan EXPO survey. *J Am Med Dir Assoc.* 2017;18(1):88 e17-88 e24.

3. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, et al. Sarcopenia: European consensus on definition and diagnosis: Report of the european working group on sarcopenia in older people. *Age Ageing.* 2010;39(4):412-423.
4. Sallinen J, Stenholm S, Rantanen T, Heliovaara M, Sainio P, Koskinen S. Hand-grip strength cut points to screen older persons at risk for mobility limitation. *J Am Geriatr Soc.* 2010;58(9):1721-1726.
5. Zammit AR, Robitaille A, Piccinin A, Muniz-Terrera G, Hofer SM. Associations between aging-related changes in grip strength and cognitive function in older adults: A systematic review. *J Gerontol A Biol Sci Med Sci*. 2019;74(4):519-527.
6. Musalek C, Kirchengast S. Grip strength as an indicator of health-related quality of life in old age-A pilot study. *Int J Environ Res Public Health.* 2017;14(12):1447. doi:10.3390/ijerph14121447
7. Stevens PJ, Syddall HE, Patel HP, Martin HJ, Cooper C, Aihie Sayer A. Is grip strength a good marker of physical performance among community-dwelling older people? *J Nutr Health Aging.* 2012;16(9):769-774.
8. Leong DP, Teo KK, Rangarajan S, et al. Prognostic value of grip strength: findings from the Prospective Urban Rural Epidemiology (PURE) study. *Lancet.* 2015;386(9990):266-273.
9. Granic A, Davies K, Jagger C, R MD, Kirkwood TBL, Sayer AA. Initial level and rate of change in grip strength predict all-cause mortality in very old adults. *Age Ageing.* 2017;46(6):970-976.
10. Cooper R, Kuh D, Hardy R, Mortality Review G, Falcon, Teams HAS. Objectively measured physical capability levels and mortality: systematic review and meta-analysis. *Br Med J.* 2010;341:c4467.
11. Bohannon RW. Hand-grip dynamometry predicts future outcomes in aging adults. *J Geriatr Phys Ther.* 2008;31(1):3-10.
12. Wang YC, Bohannon RW, Li X, Sindhu B, Kapellusch J. Hand-grip strength: normative reference values and equations for individuals 18 to 85 years of age residing in the United States. *J Orthop Sports Phys Ther.* 2018;48(9):685-693.
13. Schlaff RA, Baruth M, Boggs A, Hutto B. Patterns of sedentary behavior in older adults. *Am J Health Behav.* 2017;41(4):411-418.
14. 2019 Physical Activity Council's overview report on U.S. participation. http://physicalactivitycouncil.com/PDFs/current.pdf. Published 2019. Accessed May 22, 2019.
15. National Senior Games Association. History of the NSGA. https://nsga.com/history. Published 2019. Accessed May 22, 2019.
16. Jordre B, Schweinle W, Beacom K, Graphenteen V, Ladwig A. The five times sit to stand test in senior athletes. *J Geriatr Phys Ther.* 2013;36(1):47-50.
17. Glenn JM, Vincenzo J, Canella CK, Binns A, Gray M. Habitual and maximal dual-task gait speeds among sedentary, recreationally active, and masters athlete late middle-aged adults. *J Aging Phys Act.* 2015;23(3):433-437.
18. Jordre B, Schweinle W, Oetjen S, Dybsetter N, Braun M. Fall history and associated physical performance measures in competitive senior athletes. *Top Geriatr Rehabil.* 2016;32(1):1-16.
19. Kelsey JL, Procter-Gray E, Hannan MT, Li W. Heterogeneity of falls among older adults: implications for public health prevention. *Am J Public Health.* 2012;102(11):2149-2156.
20. Peolsson A, Hedlund R, Oberg B. Intra- and inter-tester reliability and reference values for hand strength. *J Rehabil Med.* 2001;33(1):36-41.
21. Mathiowetz V, Weber K, Volland G, Kashman N. Reliability and validity of grip and pinch strength evaluations. *J Hand Surg Am.* 1984;9(2):222-226.
22. Conforto I, Samir C, Chausse F, Goldstein A, Pereira B, Coudeyre E. Comparison of psychometric properties between the Labin, a new electronic dynamometer, and the Jamar: Preliminary results in healthy subjects. *Hand Surg Rehabil.* 2019;38(5):293-297.
23. Bohannon RW. Minimal clinically important difference for grip strength: a systematic review. *J Phys Ther Sci.* 2019;31(1):75-78.
24. Climstein M, Walsh J, Debeliso M, Heazlewood T, Sevene T, Adams K. Cardiovascular risk profiles of world masters games participants. *J Sports Med Phys Fitness.* 2018;58(4):489-496.
25. Brisk B, Jordre B, Schweinle W. Cardiovascular disease, diabetes and anthropometric measures in competitive senior athletes. Poster presented at: ExPAAC; July 2016; Indianapolis, IN.
26. Villafane JH, Valdes K, Bertozzi L, Negrini S. Minimal clinically important difference of grip and pinch strength in women with thumb carpometacarpal osteoarthritis when compared to healthy subjects. *Rehabil Nurs.* 2017;42(3):139-145.
27. Puh U. Age-related and sex-related differences in hand and pinch grip strength in adults. *Int J Rehabil Res.* 2010;33(1):4-11.
28. Abe T, Thiebaud RS, Loenneke JP. Age-related change in handgrip strength in men and women: is muscle quality a contributing factor? *Age.* 2016;38(1):28.
29. Wang YC, Bohannon RW, Kapellusch J, et al. Between-side differences in hand-grip strength across the age span: Findings from 2011-2014 NHANES and 2011 NIH Toolbox studies. *Laterality.* 2019;24(6):697-706.
30. Roberts HC, Denison HJ, Martin HJ, et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. *Age Ageing.* 2011;40(4):423-429.

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