Original Article

Normative reference values on handgrip strength among healthy adults of Dhulikhel, Nepal: A cross-sectional study

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Abstract

Context: Handgrip strength (HGS) is the amount of static force that the hand can generate around the dynamometer and can be defined as the ability of the hand to hold the objects between the thumb and fingers. Handgrip measurement is simple but also a valid measure of overall muscle strength and also provides an objective index of functional integrity of upper extremity. **Aims:** To provide population-based HGS reference values for Nepalese adults from 19 to 70 years of age. **Settings and Design:** A cross-sectional study was conducted in Dhulikhel community among 526 participants. **Methods and Materials:** Jamar Dynamometer was used for measuring HGS based on the recommendation provided by the American Society of Hand Therapists. **Statistical Analysis Used:** Data were analyzed using STATA version 14. **Results:** Men exhibited higher HGS compared to women with maximum grip strength observed in age group of 19–29 which were 47.24 kg and 32.51 kg for men and women, respectively. HGS decreases with increasing age in both dominant and nondominant hands. **Conclusions:** The normative reference values provided in this study may serve as a guide for interpreting grip-strength measurements obtained from tested individuals.

Keywords: Dynamometer, handgrip strength, Nepalese, reference values

Introduction

Handgrip strength (HGS) is the amount of static force produced by the hand.[1,2] It is an important outcome measure to determine hand function while treating upper-extremity diseases and can be used as an alternative measure to predict total body strength.[3,4] HGS is a central marker for the onset of sarcopenia and it predicts functional ability and disability.[5-7] HGS also serves as global assessment component for adults and elderly in primary care.[8] Normative values of grip strength of different countries cannot be taken as reference value in our context. Therefore, the study aims to establish reference values for HGS among Nepalese population. Ethics approval was obtained from the Institutional review committee of Kathmandu university on 18th May 2018.

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Subjects and Methods

Permission was also obtained from Dhulikhel Municipality. The purpose of the study was explained and written consent was obtained from the participants prior to the data collection. The privacy and confidentiality of the subject were maintained throughout the study and thereafter.

This was a quantitative cross-sectional study with non-probability convenient sampling conducted among healthy individuals of Dhulikhel, Nepal from age 19-70 years. The data was collected from June- August 2018. The required sample size was calculated based on the formula $n = (Z\alpha_{/2} + Z\beta)^2 (2\sigma^2)/(\mu_{1-}\mu_2)^2$ where,

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$Z\alpha_{/2}$ is desired level of statistical significance, $Z\beta$ is desired power, $2\sigma^2$ is a measure of variability and $(\mu_1-\mu_2)^2$ was minimal meaningful difference or effect size. The calculated sample size was 526. Among 543 participants screened, 526 participants met the inclusion criteria and were included in the study while 17 were excluded because of the conditions such as fracture, rheumatoid arthritis, and cervical radiculopathy and few did not give consent to participate.

Jamar® Hand Dynamometer was used to test the grip.[9] The procedure was explained and the technique was demonstrated to each participant based on the standard procedure recommended by American society of hand therapists. Subjects were positioned in a straight back chair with both feet flat on the floor. For the arm to be tested, the elbow was flexed to 90°, the forearm in neutral position, wrist in 0–15° of extension, and 0–15° of ulnar deviation. The fingers were flexed as needed for a maximal contraction. A verbal command of "Squeeze! Harder! Harder! Relax!" was given by the examiner. Three trials were conducted to measure the average (mean) HGS with 1-minute rest in-between each trial.

Statistical analysis

Data were analyzed statistically using Stata version 14. Descriptive statistics were generated to characterize the sample in terms of basic characteristics. HGS was calculated separately for males and females, by different age groups. The difference in HGS between males and females, separately for each age group, was tested using the two-sample *t*-test. The equality of HGS across different age groups, separately for males and females, was tested using the mvtest command that allows for the comparison of means across more than two groups. The relationship between HGS and age was also analyzed by calculating Pearson's correlation coefficients. $P < 0.05$ was considered statistically significant.

Table 1: Summary statistics

	Mean	SD	Min	Max
Age	41.69962	14.1384	19	69
HGS_R	36.24831	10.89051	13.33	66
HGS_L	35.90095	10.75198	12.67	64.33
HGS_R (excluding the left-dominant)	36.26066	10.88619	13.33	66
HGS_L (excluding the left-dominant)	35.87647	10.71973	12.67	64.33
Gender	Frequency	Percent		
Male	270	51.33		
Female	256	48.67		
Dominance				
Right dominant	507	96.39		
Left dominant	7	1.33		
Ambidextrous	12	2.28		
Occupation				
Farmer	138	26.24		
Housewife/husband	87	16.54		
Teacher	68	12.93		
Students	42	7.98		
Others	191	36.31		

HGS: handgrip strength

Results

In the sample of 526 individuals, 270 were male and 256 were female. The average age was 41.7 years. The youngest person in the sample was aged 19 and the oldest person 69. Most (96.39%) of the sampled individuals were right dominant, with only 7 individuals left dominant and 12 individuals ambidextrous. Occupation-wise, more than a quarter were farmers, some 17% were stay-at-home moms/dads, 13% were teachers, 8% were students, and over one-third belonged to other occupations. The mean right HGS was 36.25 (minimum 13.33 and maximum 66). The mean left HGS was 35.90 (minimum 12.67 and maximum 64.33). When we exclude individuals with a dominant left hand, the mean and standard deviation of the grip strengths of both hands are similar to those of the full sample Table 1.

Before we analyze how handgrip strength varies with age and gender, we note that while the results below cover the full sample, they also hold when dropping the seven individuals who had a dominant left hand.

Relationship between handgrip strength and gender

Males have significantly higher handgrip strength than females, for both right [Table 2] and left [Table 3] hands. On the right hand, males have a higher strength of 14.87 on average. For the left hand, males have a higher strength of 14.80. *t*-tests show that the differences are statistically significant at less than 1% level, and they are present for all age groups.[1]

Relationship between handgrip strength and age

Handgrip strength, whether that of the left hand or the right hand, declines with age, with a correlation coefficient of at least − 0.5, for both males and females [Figures 1 and 2]. The correlations are significant at less than 1% level.

When dividing individuals into five age groups, we find that among males [Table 4] as well as females [Table 5], both right and left HGSs decline when moving to higher age groups. For both males and females, the means in the five age groups are statistically different from one another, as per a test of equality of group means that yield a *P* value of < 0.00 (using mvtest in Stata).

Discussion

This study provides the reference value of HGS among 526 healthy adults from the age of 19–70 years. The maximum grip strength was observed in the male rather than the female population with the highest grip strength for both populations observed in the cluster of 19–29 years, which is 47.24 kg and 32.51 kg for men and women, respectively. The result of this study is similar to other countries where HGS was maximum in the age group of 19–29 in both the male and female population with the reference value of 51.2 kg and 32.0 kg in Swiss population, 54.4 kg and 28.5 kg in Iranian population, and 32.08

1 The tests in Tables 2 and 3 assume equal variance for males and females, but the results hold when unequal variance is assumed.

kg and 24.52 kg in Indian population.[1,3,10] Likewise, in this study, HGS was found to decrease with age which is also similar to the findings from different kinds of literature. Though a similar pattern of HGS was observed among all the age groups from different countries, the mean value of HGS in our population was less. This might be due to various factors such as height, weight, BMI, and nutrition.[3,11-13] Literature has shown a stronger correlation of HGS with height (r = 0.31, $P < 0.001$) and with BMI (r = 0.11, $P < 0.001$). Since Nepalese populations have shorter stature as compared to individuals in other countries, the mean HGS might have been lesser in our population.[14] An individual with greater height will have larger arms that have greater lever arm for force generation, thus resulting in effective amount of force generation.[15,16] Malnourishment is one of the major causes of disability in Nepal and could be another important factor contributing to the lower HGS in Nepalese population. Though the lifestyle and occupational status of Nepal and India are similar, the HGS is higher in this study when compared to India which might be due to the greater prevalence of undernourishment in Indian population, leading to insufficient daily dietary energy requirement.[17] The intake of low dietary food, inadequate micronutrients, seasonal availability of foods, and poverty are the major factors leading to poor nutritional status in Nepal.[13] Reduced nutritional intake results in a compensatory loss of whole-body protein which is preferably lost from muscle mass which is the body's largest protein reserve. The cellular changes following this lead to decreased protein synthesis and increased proteolysis leading to fiber atrophy. This, in turn, leads to decreased muscle strength and muscle function.[18]

Table 2: Differences in right handgrip strength between males and females

Age	Male mean	Female mean	Difference	*P*	(*P*) Male >Female
19-29	47.41	33.11	14.29	0.00	0.00
30-39	47.00	31.95	15.05	0.00	0.00
40-49	44.33	27.56	16.77	0.00	0.00
50-59	38.02	26.30	11.71	0.00	0.00
60-70	33.32	23.63	9.69	0.00	0.00
Total	43.48	28.62	14.87	0.00	0.00

Table 3: Differences in left handgrip strength between males and females

Age	Male mean	Female mean	Difference	*P*	(*P*) Male >Female
19-29	47.10	31.91	15.18	0.00	0.00
30-39	46.09	31.70	14.38	0.00	0.00
40-49	43.79	27.21	16.59	0.00	0.00
50-59	38.20	26.64	11.57	0.00	0.00
60-70	33.35	23.60	9.75	0.00	0.00
Total	43.10	28.30	14.80	0.00	0.00

Grip strength measurement can be an easy, quick, and economical means to stratifying people who are at the risk of sarcopenia in a primary care service.[19] With aging, HGS reduces significantly than lower limb strength.[20] This reduction in grip strength could be due to the mechanism of sarcopenia which is age-related loss of muscle mass. The cellular changes occurring with aging lead to atrophy and loss of type II muscle fibers which ultimately lead to age-related loss of muscle mass. During the age of 30–80 years, there is a 30% reduction in muscle mass which leads to qualitative and quantitative decrease in muscle fibers resulting in decrease in specific force production.[21]

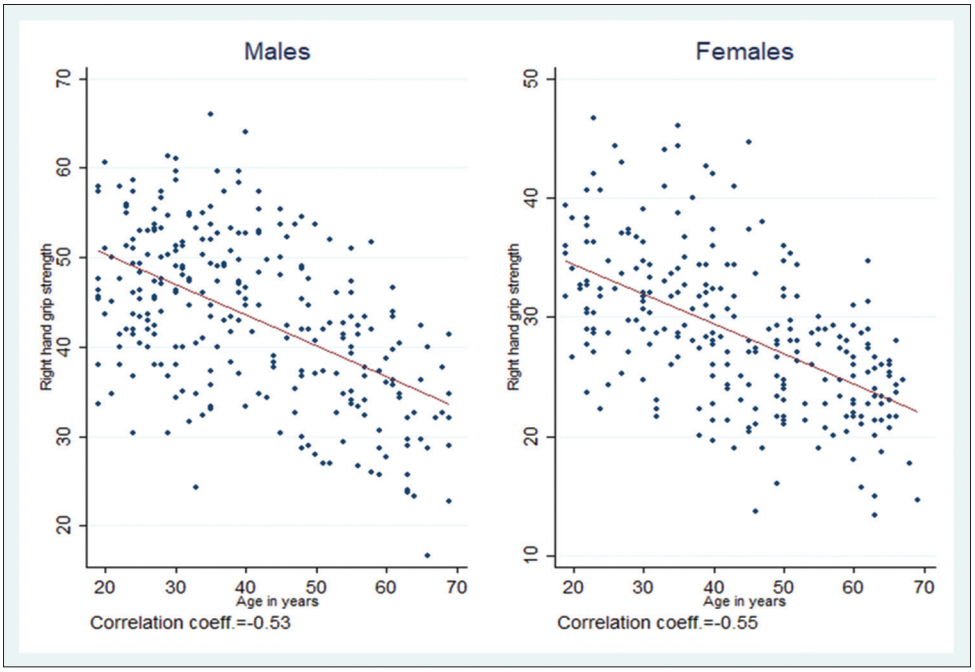

Figure 1: Correlation between right handgrip strength and age

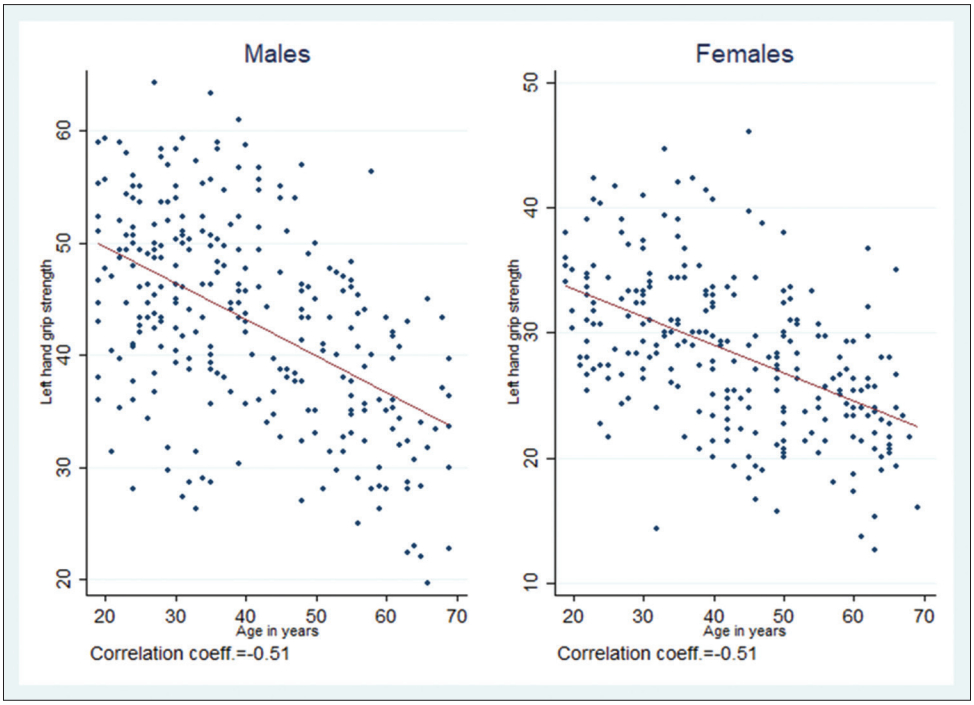

Figure 2: Correlation between left handgrip strength and age

Table 4: Right and left handgrip strength of males across age groups

Age group	*n*	Right		Left	
		Mean	SD	Mean	SD
19-29	77	47.41	7.29	47.10	7.66
30-39	70	47.00	8.25	46.09	8.55
40-49	45	44.33	8.49	43.79	7.66
50-59	44	38.02	7.41	38.20	7.40
60-70	34	33.32	6.98	33.35	6.87
Total	270	43.48	9.20	43.10	9.08

Table 5: Right and left handgrip strength of females across age groups

Age group	*n*	Right		Left	
		Mean	SD	Mean	SD
19-29	50	33.11	5.56	31.91	5.03
30-39	56	31.95	5.59	31.70	5.66
40-49	55	27.56	6.42	27.21	6.25
50-59	45	26.30	4.49	26.64	4.53
60-70	50	23.63	4.36	23.60	4.85
Total	256	28.62	6.40	28.30	6.19

The highest grip strength in males than females has been already explained in earlier studies. Greater grip strength in male population has been explained by androgen hormone produced by men at puberty which promotes the enlargement of muscle cells and performs in coordinated manner to function by acting in several cells' types in skeletal muscles.[22] Studies have also explained the greater male variance in HGS with increased environmental influences such as participation of male population in extracurricular activities involving upper extremity strength.

Literature suggests that the dominant right hand is 10 times stronger than the left.[23,24] There is a higher percentage of motor unit recruitment at lower absolute force levels in dominant hand whereas, in nondominant hand, there is a spread out recruitment pattern.[24] But in this study, the result does not show difference in HGS in dominant and nondominant hand which could be due to the use of both the hands in farming activities.[25]

Conclusions

This study provides normative reference data for clinical use in hand and upper limb rehabilitation which could be valuable in the assessment and rehabilitation of the strength of patients with various upper limb disabilities.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient (s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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