



Normal values for hand grip strength in healthy Nigerian adults

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Summary

Background: Assessment of hand grip strength is used in a wide range of clinical settings particularly during management of hand injuries and diseases affecting hand function. This study aimed to determine age and gender specific normal values of hand grip strength in healthy adults in Nigeria and compare values obtained with those in the Western population.

Materials and methods: Hand grip strength was measured using the Baseline Hydraulic Dynamometer. Results were analyzed with SPSS version 15.

Results: Two hundred and forty two participants comprising 163 males and 79 females were recruited. Mean values for hand grip strength on the right and left hands were 32.1 ± 7.6 kg and 30.7 ± 7.7 kg in males and 20.3 ± 5.3 kg and 18.7 ± 5.3 kg in females. Males showed significantly higher grip strength on the right and left hands ($p=0.000$, $p=0.000$) than in females. Grip strength peaked in the 30-39 year age group in males and females. In females a positive correlation was found between the grip strengths in both hands with weight, height and body mass index. Normal grip strength in the Western population is at least 1.6 times higher than in this study.

Conclusion: The study has been able to establish normal values for handgrip strength among healthy adults in Nigeria, which differ from that in the Western population. There is the need for further studies in other regions of Nigeria in order to establish national values.

Keywords: Handedness, hand injury, hand assessment.

Introduction

The hand differs from any other part of the body, in that it requires coordinated motion, stability, strength and sensation to perform even simple tasks adequately. Injury to the hand results in varying degrees of disability depending on the severity of the injury. With the increase in mechanized farming, industrialization and the non-availability of protective shields, hand trauma is not only more frequent but also more severe resulting in crush injuries and amputations^{1,2}. This leads to varying degrees of functional impairment and suboptimal use of the hand that adversely affects the individual's quality of life and activities of daily living. Evaluation of the injured hand is usually done to assess an acute injury, to diagnose chronic injuries prior to reconstruction, to evaluate function as well as disability.

Restoration of function after injury is the goal of hand surgeons. In order to assess the effectiveness of surgery to the hand and the subsequent progress of rehabilitation programs, hand assessment tools still remain important. In reporting hand injuries outcome measurements lay more emphasis on function as it correlates with the performance of the activities of daily living. Normal baseline data are required for interpretation of evaluation data; to set realistic treatment goals; and to assess a patient's ability to return to employment³. They are also important for medico-legal reasons. The shortcomings of using the opposite hand as a reference include underestimation of intra-individual changes in contralateral strength during the injury period and the presence of bilateral injury⁴.

Estimates of baseline values are usually obtained from those published in the literature. Due to differences in population demographics, authors have emphasized the importance of choosing the appropriate reference with which to compare evaluated handgrip strength values⁵. It is therefore pertinent to know the values that are consistent with the patient's sex, race, hand dominance and preoperative occupational exposure that may differ from those available in the current literature. The aim of the study was to determine age and gender specific normal values of handgrip strength in healthy adults in Nigeria and compare values obtained with those in the Western population.

Methods

This was a community-based cross sectional study carried out over a one year period between October 2009 and October 2010 on adults in Ibadan within the ages of 20 and 79 years. The inclusion criteria were lucid consciousness, no history of mental or psychological illness, no history of alcohol misuse, no usage of drugs or history of disease that may cause sensory deficit or influence cooperation and the ability to display independence in the activities of daily living. The exclusion criteria were a positive history of inflammatory disease, the presence of neurologic disease of the upper limbs and any traumatic event of the upper limbs impairing performance of activities of daily living

The questionnaire was structured into two parts. The first part consisted of direct answer questions. Questions 1-8 provided data on the participants' demography and questions 9-16 were questions which sought to determine the eligibility of the participant for the study and anthropometric measurements of weight, height and body mass index. The hand span was measured by first instructing that the hand be opened as wide as possible and placed on a plain paper. The outer lateral border of the distal phalanx of the little finger and thumb were marked as points on the paper. The distance between these two points, which is the hand span, was measured and recorded. The second part obtained the desired grip strength measurements.

Grip strength was measured using the Baseline hydraulic hand dynamometer (Manufactured by Fabrication Enterprises Incorporated), figure 1. Measurements were done in a standardized manner based on the American Society for Hand Therapy (ASHT) recommendations⁵. The subjects were seated with their shoulders adducted and neutrally rotated, elbow flexed at 90° with the forearm and wrist in neutral position.



Figure 1: Baseline Hydraulic Dynamometer

They were asked to grip the dynamometer handle maximally. Three consecutive attempts with 1-minute interval were measured in kilograms. All measurements were done on setting II. The same dynamometer was used for all participants. Calibration of the instrument was performed at the factory at the time of manufacture and the calibration reset to zero before use for the next participant. The arithmetic mean of three measurements was used for statistical analysis. Ethical approval was obtained from the University of Ibadan/University College Hospital Institutional Review Committee.

Statistical analysis was done using the Statistical Package for Social Sciences (SPSS) version 15.0. The data were analyzed using descriptive indices (mean and standard deviation) for age and sex distribution. Inferential statistics involving independent sample t tests were used for comparison of grip strength tests by sex, hand dominance and laterality. Correlation between grip strengths and tested variables (height, weight, body mass Index and hand span) was explored by a bivariate analysis using Pearson's correlation coefficient. A p-value of <0.05 was considered statistically significant.

Results

Handgrip strength was measured on the right and left hand of 242 adults aged between 20 and 80yrs. The age and sex distribution of the participants are as shown in table 1. Of the 242 participants 163 (67.4%) were male and 79 (32.6%) were female. Two hundred and nine (86.4%) participants were right hand dominant comprising 139 (85.3%) male and 70 (88.5%) female participants, while 31 (12.4%) were left hand dominant comprising 23 (14.1%) male and 8 (10.1%) female participants, table 2.

Table 1: Age distribution of the 242 participants stratified by sex

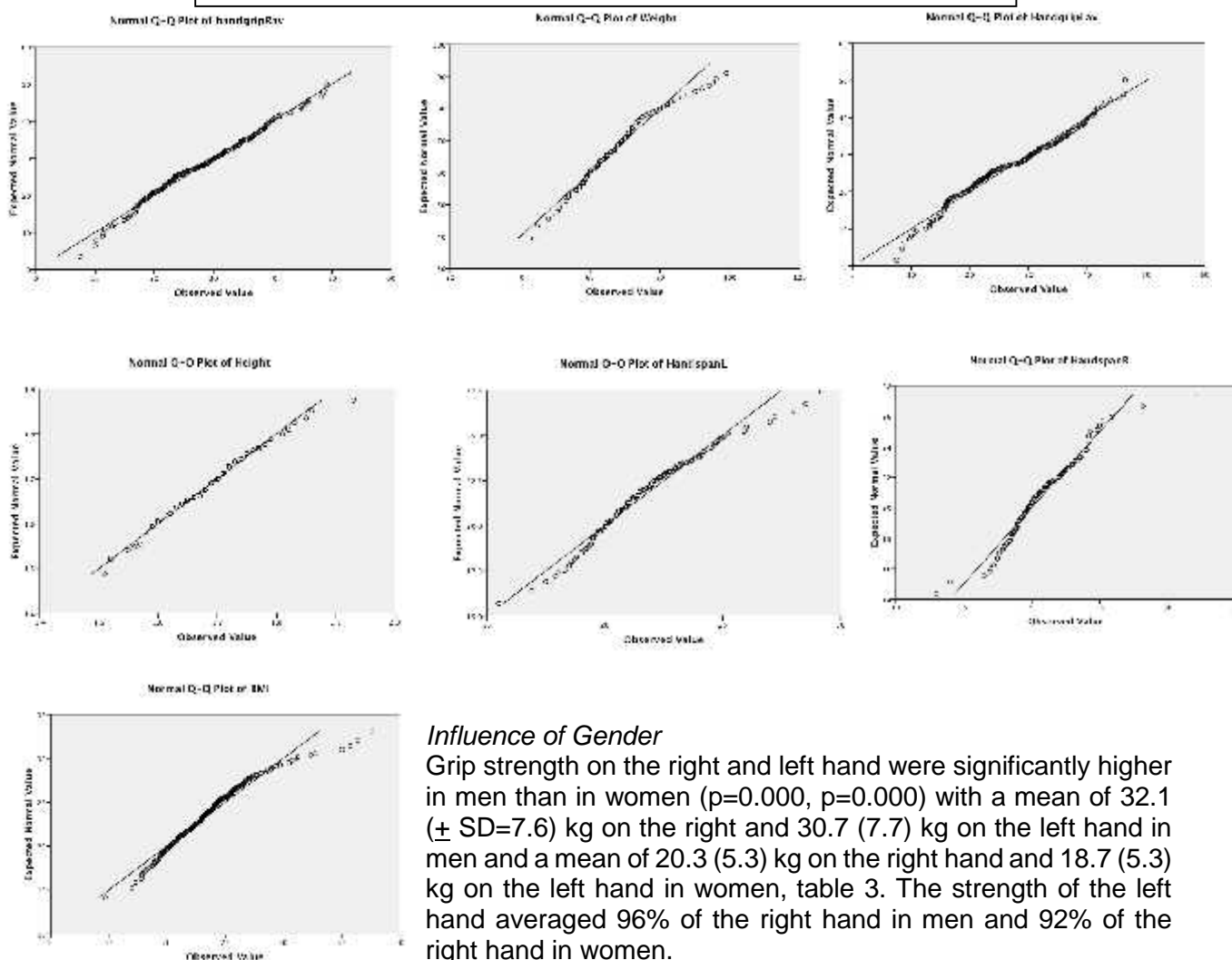
Age group	Male N (%)	Female N (%)	Total N (%)
20-29	48 (29.4)	21 (26.6)	69 (28.5)
30-39	68 (41.7)	20 (25.3)	88 (36.4)
40-49	29 (17.8)	22 (27.8)	51 (21.1)
50-59	11 (6.7)	12 (15.2)	23 (9.5)
60-69	5 (3.1)	3 (3.8)	8 (3.3)
70-70	1 (0.6)	-	2 (0.8)
>80	1 (0.6)	-	1 (0.4)
Total	163	79	242

Table 2: Hand dominance of the participant

Hand dominance	Male N (%)	Female N (%)	Total N (%)
Right	139 (85.3)	70 (88.5)	209 (86.4)
Left	23 (14.1)	8 (10.1)	31 (12.4)
Missing	1 (0.6)	1 (0.4)	2 (0.8)
Total	163 (100)	79 (100)	242 (100)

Q-Q plots showing normal distribution for grip strength and all anthropometric measures were confirmed before analysis of the data, Figures 2a-g.

Figures 2a-g: Normal distribution for grip strength and all anthropometric measurements



Hand	Sex	Mean handgrip strength (kg)	SD	p
Right	Male (n=163)	32.07	7.6	0.000
	Female(n=79)	20.25	5.3	
Left	Male (n=163)	30.70	7.7	0.000
	Female(n=79)	18.7	5.3	

Table 3: Independent sample t test comparison of right and left hand grip strengths between males and females

Influence of handedness

Grip strength was dependent on handedness. Table 4 shows that the right handgrip strength was significantly stronger than the left in the right hand dominant participant ($p=0.00$), and the left handgrip significantly stronger than the right in the left hand dominant participant ($p=0.00$).

Hand dominance	Measured Grip	Mean (kg)	SD	p
Right	Right (n=209)	28.3	8.86	0.00
	Left (n=209)	26.33	8.74	
Left	Right (n=31)	28.28	8.58	0.00
	Left (n=31)	30.03	9.91	

Table 4: Independent samples t test comparison of right and left hand grip strength based on hand dominance

There was no significant difference in the right handgrip strength between right and left hand dominant participants. However the left handgrip strength was significantly higher for left hand dominant than right hand dominant participants, table 5.

Handgrip	Hand dominance	Mean	SD	p
Right	Right (n=209)	28.2	8.9	0.98
	Left (n=31)	28.3	8.6	
Left	Right (n=209)	26.3	8.7	0.031
	Left (n=31)	30.0	9.9	

Table 5: Independent sample t test comparison of right and left hand grip strength between right and left hand dominant participants

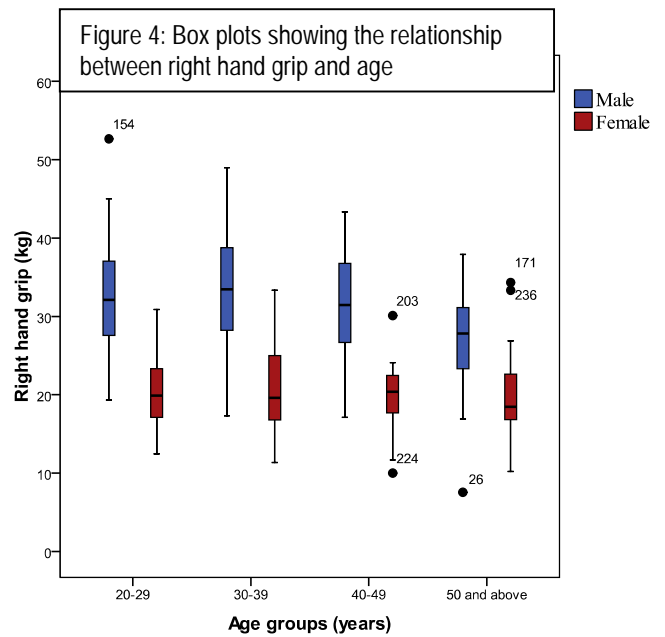
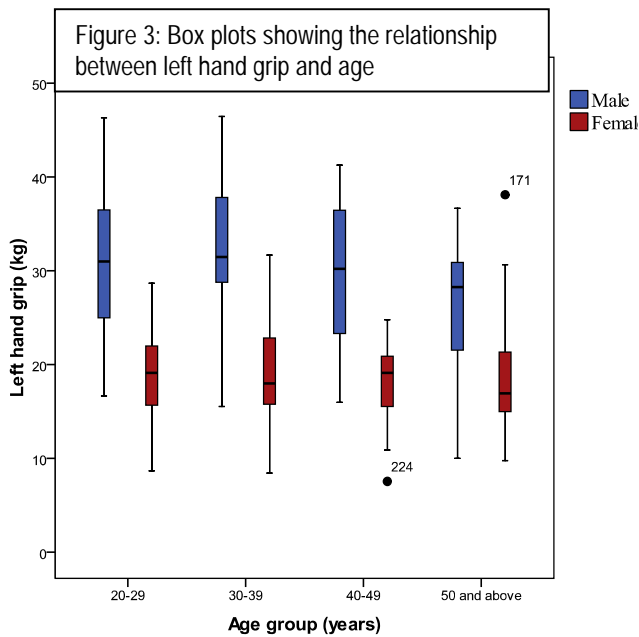
When stratified by sex, there was no significant difference of the right handgrip strength between right and left hand dominant males ($p=0.83$), table 6. However the left hand dominant male showed a significantly higher left grip strength than his right hand counterpart ($p=0.03$). For the females the right handgrip was greater for the right hand dominant person and the left handgrip greater for the left hand dominant person. These differences were not statistically significant ($p=0.27$, $p=0.91$).

Sex	Measured side	Hand dominance	Mean	SD	p
Males	Right	Right	32.09	7.78	0.83
		Left	31.71	6.40	
	Left	Right	30.14	7.71	0.03
		Left	33.88	7.26	
Females	Right	Right	20.60	5.16	0.27
		Left	18.42	6.09	
	Left	Right	18.76	4.90	0.91
		Left	18.97	8.14	

Table 6: Handgrip strength stratified by sex and hand dominance

Influence of Age

Grip strength varied with age. The greatest strength was seen in the 30-39 year age group in men and women, figures 3 and 4.



Influence of Anthropometric Measures

The Pearson's correlation between the computed constitutional variables and the grip strength showed that there was no correlation between the grip strength test on the right and left hand in males with the weight, height, body mass index and hand span. In females a positive correlation exists between the grip strengths on the right and left hand with the weight, height and body mass index. No correlation with the hand span, table 7. A summary of the normal values for male and female handgrip strength obtained in this study is presented in tables 8 and 9.

Table 7: Pearson's correlation between grip strength and constitutional variables

Variable	Male		Female		
	Right	Left	Right	Left	
Weight	.173	.111	.359**	.385**	**Correlation is significant at 0.01 level *Correlation is significant at 0.05 level
Height	.125	.127	.286*	.306**	
Body Mass Index	.109	.045	.252*	.263*	
Hand span	.073	.112	.061*	.112	

Table 8: Summary of normal values for male grip strength obtained in this study

Age (yrs)	Right grip strength (kg)				Left grip strength (kg)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
20-29	33	7	19	53	31	7	17	46
30-39	33	8	17	49	32	8	16	46
40-49	31	7	17	43	30	8	16	41
>50	27	8	8	38	26	8	10	37

Grip Strength comparison in different studies.

A comparison of the age at which the peak mean handgrip strength was obtained in this study was done with those of other studies; the values obtained approximate more closely that of studies in Asia. This is illustrated in table 10.

Table 9: Summary of normal values for female grip strength obtained in this study

Age (yrs)	Right grip strength (kg)				Left grip strength (kg)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
20-29	20	5	12	30	19	5	9	29
30-39	21	6	11	33	19	6	8	32
40-49	20	5	10	30	18	4	8	25
>50	20	6	10	34	19	7	10	38

Table 10: Comparison of age at which peak mean handgrip strength was obtained between this study and other studies

Population	Women		Age (yrs)	Men		Age (yrs)
	DGrip strength(kg)	NDGrip strength(kg)		DGrip strength(kg)	NDGrip strength(kg)	
Nigerian ²⁷	25.1	23.0	20-29	36.3	32.2	20-29
Swiss ²⁸	34.0	34.7	40-44	55.9	53.4	35-39
German ²⁶	33	32	30-39	54	52	30-39
Asian ³⁰	19	17	25-34	31	28	25-34
UK ⁷⁰	28.5	26.6	35-44	48.6	44.8	35-44
This study	21	19	30-39	33	32	30-39

Discussion

Handgrip strength has been defined as the measure of maximum voluntary force of the hand, being the simplest method of assessing muscle function⁶. Normative data provide a reliable method in clinical evaluation of the impact from several injuries to either the musculoskeletal or the neurological system of the hand. These data have a major role in assessing the effectiveness of a surgical procedure and offer an objective clinical approach for patient follow up.

This study has shown statistically significantly higher grip strength in males compared to females being broadly consistent with the work of other authors^{4,7,8}. Previous research found either lower dominant grip strength in left-handed people or no significant difference between the hands⁴. While right-handed people had higher grip strength in their dominant side compared to their non-dominant side. This study showed that right handed as well as left handed participants had higher strength values on their dominant side, similar to the findings by Werle et al in the Swiss population⁹.

Some studies have reported a significant correlation of grip strength with height and weight^{4,8}. This was true in this study but only pertaining to females. There was also a positive correlation between the handgrip strength and BMI in females in this study contrary to what has been reported in other studies that found no relationship between grip strength and BMI in either males or females¹⁰.

It is generally believed that the handgrip strength reaches a peak between the ages of 25 and 50 years¹². Before that age there is a progressive increase of hand strength and especially grip strength. After the age of 50, most individuals experience a decline in their grip strength with increasing age. In this study the grip strength peaked in the fourth decade in males and females. A similar study in Nigeria found the grip strength to peak between the 20-29 year age group for both sexes⁷. Anakwe et al found grip strength to be greatest in the 35-44 year age group¹². The age for maximum grip strength approximates those of other studies and is higher than the previous study carried out in Nigeria⁷. The strength of this study is its community based setting. The previous study was carried out in a University setting. The maximum grip strength is lower in this study than previous studies being closer to those obtained from Asian population³⁰. This further buttresses the point for cautious generalization of data from the Western population.

The limitations of the study were the recruitment of a non-representative elderly population limiting the conclusions that can be drawn from this subset of people. In addition, the preponderance of males in the study over females may be due to the fact that males were more willing to participate in the study than females. The convenience sampling for the streets chosen could also be contributory as more males than females were found on the streets. The influence of occupation on the grip and pinch strength was not evaluated.

This study concludes that men have more powerful handgrip strength than women and the dominant hand is stronger than the non-dominant hand in both sexes. The handgrip strength varied with age in both sexes. It also showed values that differ from reference values in the Western populations and has therefore been able to buttress the need for reference values for each population as population parameters may differ according to race and environmental influences. This study has therefore established normal values for grip strength according to age and sex for healthy adults in a Nigerian population. The values obtained in this study could be used for comparing and assessing hand function pre- and post-operatively following hand injuries and in non-traumatic hand conditions in Nigeria. There is the need for further studies in other regions of Nigeria in order to bring about a national standard.

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Conflict of interest statement

None

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