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Influence of body and hand anthropometric characteristics on handgrip strength in young Nigerian women

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Abstract

Background and aim Women are well known for having lower handgrip strength (HGS) compared to men. However, factors contributing to lower HGS in women remain unclear. This study investigated the influence of body and hand anthropometric characteristics (HAC) on HGS among young Nigerian undergraduate women.

Methods Apparently healthy 500 young female adults from a Nigerian University were recruited conveniently. Age and physical characteristics were recorded. Right and left (R&L) HGS were measured using an electronic dynamometer. HAC including R&L arm girth (ArG), forearm girth (FaG), wrist girth (WrG), finger span (FSp), finger breath (FBr), finger length (FLg) and palm length (PLg) were measured. Data were analysed using descriptive and inferential statistics. Alpha level was set at $p < 0.05$.

Results The mean age of the participants was 22.46 ± 3.72 years. Age and body mass index (BMI) contributed about 20.0 and 12.0% to the prediction of HGS, respectively. Similarly, R&L HAC: ArG, FaG, WrG, FSp, FBr, FLg and PLg contributed about 22.8 and 14.8% to the prediction of HGS, respectively. Significant correlations occurred between HGS and each of BMI, R&L HAC ($p < .05$). Furthermore, significant correlations were also found between age and each of R&L HAC ($p < .001$).

Conclusions Age, BMI and HAC have significant influence on the HGS of young Nigerian undergraduate women. Hence, physical factors such as weight, height, BMI, and hand anthropometric measurements are recommended as part of routine assessment for effective rehabilitation plans in the care of women with hand disability or poor hand function.

Keywords Handgrip strength, Physical characteristics, Hand anthropometric characteristics, Young women

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Introduction

Handgrip strength is the integrated performance of muscles by determining maximal grip force that can be produced in one muscular contraction [1]. It is widely accepted that HGS measurement provides an objective index of the functional integrity of the upper extremity [2, 3]. Furthermore, HGS is associated with high muscular strength and endurance in the upper extremities and may serve as a predictor of upper limb impairment, nutritional status, muscle strength and endurance during rehabilitation [4], can predict functional limitations, physical disability, risk of developing chronic non-communicable disease [1], and ability to perform activities of daily living [5, 6]. However, reports have shown that normative data for HGS vary in different demographics [7], especially between male and female individuals irrespective of age groups, disease state, occupation, and race [8–11]. Some of the factors reported for the gender differences in HGS are physical factors, including height, weight, body mass index (BMI), and bone mineral density [12]. Similarly, arm and hand characteristics, including but not limited to hand size, upper arm circumference, hand dominance, and hand shape were reported to have significant contributions to the difference in HGS between male and female [13].

However, there is limited empirical data on the impact of specific hand anthropometric characteristics (finger span, finger breath, finger length, palm length, arm girth, forearm girth, hand length, and hand width) on the lower HGS among women, whereas reports have identified hand anthropometric characteristics as important factors affecting HGS [14, 15]. Evaluating the relevance of hand anthropometric characteristics in HGS among women may help to understand if and which hand anthropometric factors contribute to the lower HGS in women and thus helping the clinicians to screen and predict HGS in women. This knowledge will further help in planning and enhancing effective rehabilitation, especially of upper extremity among women. The purpose of this study was to investigate the influence of body and hand anthropometric characteristics on HGS and also explore the relationship between HGS and specific hand anthropometric characteristics among young Nigerian women.

Methods

Subjects

This cross-sectional study involved female undergraduates of Obafemi Awolowo University, Ile-Ife, Nigeria who were 18 years and above, and were conveniently recruited into the study. Individuals without known history of musculoskeletal or neuromuscular disorder that affect the upper extremities were included. Participants with hand surgery less than six months, who were athletes and actively participating in sport activities involving upper limbs, were excluded from the study. This study was conducted at the Department of Medical Rehabilitation, College of Health Sciences, Obafemi Awolowo University (OAU), Ile-Ife, Nigeria. The sample size for this study was based on the sample size formula for proportions with population greater than 10,000 [16]. As at 2015, the Directorate of Students' Affairs of OAU estimated the population of undergraduate students to be 30,000 [17]. In order to estimate an appropriate sample size for this study, a proportion of 50% of the population with 95% confidence interval ($z = 1.96$) and an absolute standard error ($d = 0.05$) while 50% was used (0.50) and ($q = 1—p = 0.05$). Hence, a minimum sample size of 384 participants was estimated. However, additional 30% was added to the estimated sample size to enhance the study power and also accommodate possible missing data. Thus, resulting to 499.5 but rounded up to 500 participants.

Procedure

Ethical approval for this study was obtained from the Human Research and Ethics Committee (Protocol number: IPHOAU/12/897), Institute of Public Health, Obafemi Awolowo University, Ile – Ife, Nigeria. Initially, information on socio-demographic characteristics and self-reported health status was recorded. The purpose of the study was explained to prospective participants and informed consent was obtained. All tests and measurements were conducted at the same time of the day for all participants (9.00 – 14.00 h). Handgrip strength was measured using a standard adjustable handle dynamometer (Camry, EH-101, Taiwan). In line with the protocols of previous studies [18, 19], the calibration of the dynamometer was checked and found accurate.

Reliability and validity of the hand electronic dynamometer was tested in a pilot study involving 20 participants who were not included in the main study. The handgrip strength was measured in each individual using the Jamar hand dynamometers and compared the values obtained with that of electronic hand dynamometers. The tests were carried out on two different occasions (at 2 days interval) following standard procedures. The values obtained from each dynamometer were subjected to psychometric analysis to arrive at the reliability and validity of the electronic hand dynamometer. Test re-test reliability of the electronic hand dynamometer provided excellent intra-class correlation (ICC) = 0.962, while the validity was found to be adequate (ICC = 0.954 – 0.958).

Assessment of handgrip strength

A brief interview preceded the determination of the participants' muscular strength. The purpose of the interview was to determine the participants' dominant hand and to screen individuals with previous hand injury. Each participant's hand grip strength (HGS) was assessed with the aid of an electronic Camry hand grip dynamometer (Model EH—101, Taiwan) based on the recommendation of the American Society of Hand Therapist, described in our previous study [20]. Participant sat on a straight-back armless chair of standard height. Participant's test arm was held at 90° elbow flexion position with the forearm in neutral position preventing radio-ulnar deviation. The hand was positioned parallel to the forearm holding the dynamometer. Every participant was instructed to squeeze maximally and hold for 3 to 5 s until the reading is taken. Measurements were performed for both hands and the dominance was determined based on the self-report from the interview done earlier. Two measurements were taken for each upper extremity at 2-min rest interval; the average was recorded in kilogram-force (Kgf) as grip strength value. For standardization, the dynamometer was set at the second handle position. No verbal encouragement was given. Participants performed three maximum attempts for each grip strength measurements, and the mean values of these trials were recorded. A one-minute rest was given between each attempt, and hands were alternated to minimize fatigue effects. Results were recorded in kilogram force (Kgf).

Hand dimension measurements

A standard non-elastic measuring tape was used to take the hand dimension measurements to the nearest centimetre with the hand extended and relaxed while the elbow was supported on a table.

Hand span (HSp)

This was measured in both hands from the tip of the thumb to the tip of the small finger with the hand opened as wide as possible [13].

Palm length (PLg)

This was measured from the distance of the distal wrist crease up to the base of the middle finger [13].

Hand length (HLg)

The distance from the distal wrist crease to the tip of the middle finger was considered for the measurement [13].

Arm girth (ArG)

This was taken on the right side of the body. The arm was relaxed and subject was asked to roll up the sleeves and arm hanging by the side. It was measured at the bulkiest part of the bicep brachii muscle, circumferentially [13].

Forearm girth (FaG)

This was taken on the right side of the body with the sleeves rolled up and the participant held the arm out with the palm facing upwards. The measurement was taken at the bulkiest part of the common extensors group of muscles of the forearm [13].

Wrist girth (WrG)

This was measured circumferentially at the level of the radial styloid [13].

All hand anthropometric measurements were in centimetre. The body anthropometric variables, including weight, height and body mass index were assessed using standard procedures.

Data analysis

Data was summarized using descriptive statistics of frequency, percentage, mean, and standard deviation. Furthermore, inferential statistics of multiple regression analysis was used to evaluate the influence of body and hand anthropometric characteristics on HGS among the participants. Additionally, Pearson's Moment Correlation Co-efficient was used to determine the relationship between HGS, body and specific hand anthropometric characteristics of the participants. The Statistical Package for Social Sciences (SPSS) version 20.0 (SPSS Inc., Chicago, IL, USA) was used to perform the statistical analysis. Alpha level was set at $p < 0.05$.

Results

Table 1 shows physical characteristics of participants. The means of age and body mass index (BMI) were 22.46 ± 3.72 years and 21.60 ± 3.16 kg/m^2, respectively. The means of right handgrip strength (HGS), right finger span (RFSp) and right finger breadth (RFBr) were 28.96 ± 6.16 Kgf, 17.17 ± 1.22 cm and 8.77 ± 0.61 cm, respectively. Table 2 shows prediction test of right HGS with respect to body anthropometric characteristics of participants. The predictive equation for the right HGS is presented as:

$$\mathbf{RHGS} = 8.889 + 0.418(\text{age}) + 0.260(\text{weight}) + 0.010(\text{height}) - 0.238(\text{BMI});\ \mathrm{r} = 0.200$$

Table 3 shows prediction test for the left HGS with respect to anthropometric characteristics of participants. The predictive equation for the left HGS is presented as:

Table 1 Physical and hand anthropometric characteristics of participants ($N=500$)

Variable	Minimum	Maximum	Mean ± SD
Age (year)	18.00	34.00	22.46 ± 3.72
Weight (Kg)	56.00	92.00	60.58 ± 9.00
Height (m)	1.50	1.68	1.62 ± 1.05
BMI (Kg/m^2)	12.00	32.00	21.60 ± 3.16
LHGS (Kgf)	10.20	52.30	25.59 ± 5.48
RHGS (Kgf)	7.20	45.50	28.96 ± 6.16
LArG (cm)	20.00	46.00	27.74 ± 3.28
LFaG (cm)	17.00	31.00	23.60 ± 1.98
LWrG (cm)	10.00	18.00	13.37 ± 1.56
LFSp (cm)	14.00	22.00	17.31 ± 1.25
LFLg (cm)	17.00	23.00	19.83 ± 1.28
LFBr (cm)	7.00	10.50	8.61 ± 0.63
LPLg (cm)	8.00	14.50	11.51 ± 1.01
RArG (cm)	20.00	44.00	27.77 ± 3.18
RFaG (cm)	17.00	31.00	23.82 ± 1.93
RWrG (cm)	10.00	19.00	13.59 ± 1.56
RFSp (cm)	12.50	22.50	17.18 ± 1.22
RFLg (cm)	16.50	24.00	19.84 ± 1.28
RFBr (cm)	7.00	11.00	8.77 ± 0.61
RPLg (cm)	8.50	14.00	11.59 ± 0.99

Key: *BMI* Body mass index, *LHGS* Left handgrip strength, *RHGS* Right handgrip strength, *LArG* Left arm girth, *LFaG* Left forearm girth, *LWrG* Left wrist girth, *LFSp* Left finger span, *RArG* Right arm girth, *RFaG* Right forearm girth, *RWrG* Right wrist girth, *RFSp* Right finger span, *LFLg* Left finger length, *RFLg* Right finger length, *RFBr* Right finger breadth, *LPLg* Left palm length, *RPL* Right palm length

$$\mathbf{LHGS} = 11.583 + .239(\text{age}) + .180(\text{weight}) + .045(\text{height}) - .110(\text{BMI});\ \ r = .120$$

Table 4 shows prediction test for the right HGS with respect to upper limb anthropometric characteristics of participants.The predictive equation for the right HGS with respect to upper limb anthropometric characteristics is presented as:

$$\begin{aligned}\mathbf{RHGS} = & -3.817 - .201(\text{LAG}) - .110(\text{LFaG}) + .051(\text{LWrG}) \\ & - .433(\text{LFSp}) - .237(\text{LFLg}) + 1.502(\text{LFBr}) \\ & - .503(\text{LPLg}) + .321(\text{RArG}) + .372(\text{RFaG}) \\ & + .944(\text{RWrG}) + .444(\text{RFSp}) - .058(\text{RFLg}) \\ & + 1.245(\text{RFBr}) - .231(\text{RPLg});\ \ r = .228.\end{aligned}$$

Table 5 shows prediction test for left HGS with respect to upper limb anthropometric characteristics of participants. The predictive equation for the left HGS with respect to upper limb anthropometric characteristics is presented as:

$$\begin{aligned}\mathbf{LHGS} = & -3.049 + .024(\text{LArG}) - .090(\text{LFaG}) \\ & + .501(\text{LWrG}) - .290(\text{LFSp}) \\ & + .124(\text{LFLg}) + .807(\text{LFBr}) + .060(\text{LPLg}) \\ & - .032(\text{RArG}) + .314(\text{RFaG}) + .440(\text{RWrG}) \\ & + .685(\text{RFSp}) - .328(\text{RFLg}) + .310(\text{RFBr}) \\ & - .193(\text{RPLg});\ \ r = 0.148\end{aligned}$$

Table 2 Prediction test of right handgrip strength with respect to body anthropometric characteristics

	Unstandardized Coefficients		Standardized Coefficients		95% CI	
Model	B	Std. Error	B	T	Lower Bound	Upper Bound
Constant	8.889	2.090		4.253	4.782	12.996
Age	.418	.072	.253	5.796	.276	.560
Weight	.260	.064	.381	4.087	.135	.386
Height	.010	.041	.011	.233	-.071	.090
BMI	-.238	.184	-.122	-1.294	-.598	.123

Table 3 Prediction test of left handgrip strength with respect to body anthropometric characteristics

	Unstandardized Coefficients		Standardized Coefficients		95% CI	
Model	B	Std. Error	B	T	Lower Bound	Upper Bound
Constant	11.583	1.952		5.935	7.749	15.417
Age	.239	.067	.162	3.543	.106	.371
Weight	.180	.059	.296	3.032	.063	.297
Height	.045	.038	.058	1.174	-.030	.121
BMI	-.110	.171	-.063	-.641	-.447	.227

Table 4 Prediction test of right handgrip strength with respect to anthropometric characteristics of the right upper extremities

	Unstandardized Coefficients		Standardized Coefficients		95% CI	
Model	B	Std. Error	B	T	Lower Bound	Upper Bound
(Constant)	-3.817	5.651		-.675	-14.921	7.286
LArG	-.201	.292	-.107	-.691	-.775	.372
LFaG	-.110	.344	-.035	-.319	-.787	.567
LWrG	.051	.322	.013	.159	-.582	.685
LFSp	-.433	.248	-.088	-1.751	-.920	.053
LFLg	-.237	.374	-.049	-.633	-.972	.498
LFBr	1.502	.547	.153	2.747	.428	2.575
LPLg	-.503	.409	-.082	-1.230	-1.306	.300
RArG	.321	.304	.166	1.057	-.276	.919
RFaG	.372	.351	.116	1.059	-.318	1.062
RWrG	.944	.320	.240	2.947	.315	1.573
RFSp	.444	.254	.088	1.751	-.054	.942
RFLg	-.058	.375	-.012	-.154	-.795	.679
RFBr	1.245	.552	.123	2.254	.160	2.330
RPLg	-.231	.425	-.037	-.543	-1.067	.605

Key: *LArG* Left arm girth, *LFaG* Left forearm girth, *LWrG* Left wrist girth, *LFSp* Left finger span, *RArG* Right arm girth, *RFaG* Right forearm girth, *RWrG* Right wrist girth, *RFS* Right finger span, *LFLg* Left finger length, *RFL* Right finger length, *RFB* Right finger breadth, *LPLg* Left palm length, *RPL* Right palm length

Table 5 Prediction test of left handgrip strength with respect to anthropometric characteristics of the left upper limb extremities

	Unstandardized Coefficients		Standardized Coefficients		95% CI	
Model	B	Std. Error	B	T	Lower Bound	Upper Bound
(Constant)	-3.049	5.285		-.577	-13.433	7.334
LArG	.024	0.273	.015	.089	-0.512	0.560
LFaG	-.090	.322	-.033	-.279	-0.723	0.543
LWrG	.501	.301	.143	1.661	-.092	1.093
LFSp	-.290	.231	-.066	-1.254	-.745	.165
LFLg	.124	.350	.029	.356	-.563	.812
LFBr	.807	.511	.092	1.579	-.197	1.811
LPLg	.060	.382	.011	.157	-.691	.811
RArG	-.032	.284	-.019	-.113	-.591	.526
RFaG	.314	.328	.111	.956	-.331	.959
RWrG	.440	.300	.126	1.469	-.148	1.029
RFSp	.685	.237	.153	2.889	.219	1.151
RFLg	-.328	.351	-.077	-.934	-1.017	.362
RFBr	.310	.516	.034	.600	-.705	1.325
RPLg	-.193	.398	-.035	-.485	-.975	.589

Key: *LArG* Left arm girth, *LFaG* Left forearm girth, *LWrG* Left wrist girth, *LFSp* Left finger span, *RArG* Right arm girth, *RFaG* Right forearm girth, *RWrG* Right wrist girth, *RFS* Right finger span, *LFLg* Left finger length, *RFL* Right finger length, *RFB* Right finger breadth, *LPLg* Left palm length, *RPL* Right palm length

Table 6 shows summary of correlation matrix between ages, right, left hand anthropometric characteristics and HGS of participants. The result shows that there were moderate significant and positive correlations between age and weight ($r=0.375$; $p=0.001$), and weak and positive correlation between age and BMI ($r=0.267$; $p=0.001$). Furthermore, there were weak, significant and positive correlations between age and each of hand anthropometric characteristics (HAC): LArG ($r=0.118$; $p=0.001$), LWrG ($r=0.242$; $p=0.001$) and LFBr

Table 6 Correlation matrix of relationships between age, physical and hand anthropometric characteristics of participants

Variable	Age	Wt	Ht	BMI	LHGS	LArG	LFaG	LWrG	LFSp	LFLg	LFBr	LPLg	RHGS	RArG	RFaG	RWrG	RFSp	RFLg	RFBr	RPLg
Age	1																			
Wt	.375[b]	1																		
Ht	-.027	-.049	1																	
BMI	.269[b]	.864[b]	-.305[b]	1																
LHGS	.255[b]	.300[b]	.058	.219[b]	1															
LArG	.118[b]	.380[b]	.031	.339[b]	.167[b]	1														
LFaG	.177[b]	.367[b]	.010	.299[b]	.216[b]	.711[b]	1													
LWrG	.242[b]	.311[b]	.020	.224[b]	.323[b]	.347[b]	.469[b]	1												
LFSp	-.063	-.095[a]	.025	- .125[b]	.050	.096[a]	.115[b]	.103[a]	1											
LFLg	-.077	.049	.077	-.026	.042	.199[b]	.207[b]	.093[a]	.388[b]	1										
LFBr	.165[b]	.225[b]	.101[a]	.113[a]	.204[b]	.153[b]	.229[b]	.293[b]	.111[a]	.242[b]	1									
LPLg	-0.077	.009	.089[a]	-.062	.043	.110[a]	.148[b]	.102[a]	.255[b]	.601[b]	.279[b]	1								
RHGS	.362[b]	.370[b]	.022	.272[b]	.658	.217[b]	.253[b]	.338[b]	-.021	-.031	.284[b]	-.052	1							
RAG	.126[b]	.383[b]	.032	.337[b]	.176[b]	.964[b]	.708[b]	.378[b]	.101[a]	.188[b]	.163[b]	.111[a]	.240[b]	1						
RFaG	.144[b]	.381[b]	.006	.303[b]	.218[b]	.707[b]	.927[b]	.437[b]	.130[b]	.228[b]	.224[b]	.168[b]	.256[b]	.719[b]	1					
RWrG	.276[b]	.332[b]	-.015	.255[b]	.322[b]	.367[b]	.443[b]	.865[b]	.111[a]	.057	.257[b]	.074	.372[b]	.401[b]	.427[b]	1				
RFSp	.069	.091[a]	.068	.014	.175[b]	.138[b]	.159[b]	.155[b]	.537[b]	.285[b]	.177[b]	.176[b]	.120[b]	.125[b]	.158[b]	.173[b]	1			
RFLg	-.014	.096[a]	.042	.008	.045	.184[b]	.228[b]	.132[b]	.307[b]	.794[b]	.277[b]	.494[b]	.015	.176[b]	.238[b]	.105[a]	.342[b]	1		
RFBr	.138[b]	.205[b]	.129[b]	.099[a]	.181[b]	.122[b]	.174[b]	.224[b]	.078	.203[b]	.653[b]	.141[b]	.287[b]	.139[b]	.165[b]	.233[b]	.239[b]	.237[b]	1	
RPLg	-.083	.050	.087	-.016	.031	.168[b]	.211[b]	.123[b]	.232[b]	.528[b]	.272[b]	.727[b]	-.018	.164[b]	.222[b]	.089[a]	.190[b]	.635[b]	.195[b]	1

Key: *Ht* Height, *Wt* Weight, *BMI* Body mass index, *LHGS* Left handgrip Strength, *LFaG* Left forearm girth, *LFSp* Left finger span, *LFBr* Left finger breadth, *RFSp* Right finger span, *RHGS* Right handgrip Strength, *RFaG* Right forearm girth, *LArG* Left arm girth, *LWrG* Left wrist girth, *RFLg* Right finger length, *LFLg* Left finger length, *LPLg* Left palm length, *RArG* Right arm girth, *RWrG* right wrist girth, *RFBr* Right finger breadth, *RPLg* Right palm length

[a] Correlation is significant at the .05 level, [b]Correlation is significant at the .001 level

($r=0.165$; $p=0.001$), indicating increasing in age is associated with increasing in hand anthropometric parameters. Moreover, there were weak, significant and positive correlations between right HGS and each of right HAC: RFaG ($r=0.218$; $p=0.001$), RArG ($r=0.176$; $p=0.001$), RFSp ($r=0.175$; $p=0.001$) and RFBr ($r=0.181$; $p=0.001$). Similarly, there were weak, significant and positive correlations between left HGS and each of left HAC: LFaG ($r=0.216$; $p=0.001$), LArG ($r=0.167$; $p=0.001$), LFBr ($r=0.204$; $p=0.001$). The positive correlations between both right and left hand anthropometric characteristics and right and left HGS suggest that women with larger hand anthropometric may possess stronger right and left HGS irrespective of hand dominance.

Discussion

Difference in handgrip strength between Men and Women

This study investigated the influence of body and hand anthropometric characteristics on handgrip strength (HGS) among apparently healthy young female undergraduate students. Findings from our study showed that left HGS (LHGS) and right HGS (RHGS) were 25.59 ± 5.48 and 28.96 ± 6.16 Kgf respectively. Compared with what is obtained in the literature, this finding is lower than that of young male adults [20]. This is consistent with the findings of previous studies that women always demonstrating lower HGS, irrespective of age groups, compared to men [1, 20, 21]. It is not surprising that this finding (lower HGS in women) are consistent with that of previous studies for certain reasons. In general population, males are more engaged in different activities that will exert greater muscular activities and thus, greater strength. On the contrary, females are more selective in performing certain activities that are more of endurance types which may not result to increased muscle hypertrophy, hence, lower muscular strength. Furthermore, it is more likely that higher percentage of lean body mass which induces protein deposition and development of higher muscle fibres in males lends greater support for better muscular strength in males than the female counterparts. Indeed, it has been reported that male subjects retains higher HGS for more than a decade longer compared to female counterparts of the same age during life span [22]. It is not known, however, if the lower HGS found in women makes them more susceptible to disease and illness, as HGS is a consistent independent predictor of health and wellness. Further research is needed to investigate this phenomenon. Meanwhile, since studies have linked some certain activities/exercise to better HGS in men, women should be encouraged to involve in exercise and activities that promote increased muscular strength including HGS.

Association between age and handgrip strength

Age is an important factor in physical performances, including HGS. Findings from our study show that there is significant positive correlation between age and HGS. This finding is similar to a previous study that age is significantly related to HGS, especially among young adults [23]. Similarly, our study participants were all young women who are in their prime ages. At this stage of life, all physical functions are still indispensably intact, active, and agile; hence, performance of HGS is expected to be strong and at highest level during this period. Besides, it has been established that the muscular power is at peak by the third decade of life and starts to decline as age advances [24]. Corroborating this finding, Tsang confirmed that HGS peaked between the age range of 21 and 30 years [25]. Age-related decline in HGS may also be attributed to decreasing physical activity, loss of muscle mass, alteration of muscle fibres, decreasing hormone levels, and chronic diseases that come with advancing age [25]. As it is been established that HGS in women often decline faster compared to men as aging set in, therefore, women may need more screening and concerted efforts to combat possible attendants negative effects of decreasing HGS, including functional dependence, frailty, falls, etc.

Association between body anthropometric characteristics and handgrip strength

Body anthropometric characteristics have been reported to contribute to HGS in general population. Findings from our study show that weight and BMI had significant correlations with the HGS of both right and left hand of the participants. These findings corroborate with that of previous studies that reported significant correlations between HGS and anthropometric variables, such as weight, height and BMI [25–27]. However, surprisingly and different from general belief that HGS and BMI are related, a study among individuals between the ages of 18 to 65 years in Malaysia showed no significant correlation between HGS and BMI [28]. The possible explanation for the deviation may be due to greater differences in the age group of the participants in the Malaysian study. Specifically, the Malaysian study involved more than one gender, and samples of varying age and background, including staff and students of University of Malaya Medical Centre, contrary to the sample in this study [28]. Moreover, older adults tend to lose greater quantity of body adiposity, muscle mass and strength as age advances, and perhaps result into non-significant relationships between HGS and BMI. Considering specific factors that may be responsible for lack of relationship between HGS and BMI, several other factors such as hand size, ethnic difference, dominant hand, posture, joint position, hobby, frequency of testing and time of the day, daily activities or occupation may also contribute to the non-significant relationships [29, 30]. Nonetheless, our findings and report of similar studies indicate the importance of relating HGS with the body mass and height of individuals when interpreting the HGS value.

Association between hand anthropometric characteristics and handgrip strength

In line with influence of body anthropometric characteristics on HGS, our findings show that there were significant correlations between HGS and some selected upper limb anthropometric characteristics, including arm, forearm and wrist girths, finger span and finger breadth. Previous studies have reported similar significant relationships between HGS and anthropometric variables, such as arm and forearm girth, length, width, size, finger span, finger lengths and hand perimeters of healthy individuals [13, 31]. It is interesting to note that findings from our study show that linear regression analysis provides the evidence of contributions of age, BMI, and hand anthropometric characteristics (hand length, breadth and span, wrist, forearm and arm girths, and palm length) to HGS in women. Similarly, the work of Chilima and Ismail established the joint influence of age, height, and arm girth on HGS, which was reported to contribute about 24% in women's' HGS variance [32]. It is noteworthy to mention that factors responsible for gender-difference in HGS values appear to be multi-dimensional in nature. It seems the factors responsible for gender-difference in HGS are not mutually exclusive but are intertwined to describe the degree of differences in HGS between men and women of various age groups. Presently, the influence of hormones, physiological, psychological and psychosocial factors on HGS studies in both sexes are still limited in the literature. It is possible that some of these factors may be responsible for the persistent differences in the HGS between men and women. Thus, apart from other known contributing factors, clinicians may need to assess and relate the hand anthropometric characteristics of women, including arm and forearm girth, length, width, size, finger span, finger lengths and hand perimeters in HGS assessment and interpretation. This may enable effective and good rehabilitation outcomes, especially in hand rehabilitation.

Limitations to the study

Findings from our study should be carefully interpreted with cautions due to certain limitations. We did not take hand dominance or laterality of our participants into consideration as many of them were mainly right handed young women and this may be a significant shortcoming in this study. Furthermore, the design for this study was cross-sectional in nature and causal relationships cannot be established. Similarly, our participants were generally young university undergraduate women and may not be considered as true representative of Nigerian young women who may be involved in manual works. However, the strength of our study lies in its moderate and robust sample size that could possibly limit the level of bias but enhances the validity of our findings.

Conclusion

In this study we found that age, body mass index and hand anthropometric characteristics are the main factors influencing handgrip strength among young Nigerian women. Furthermore, there were significant relationships between body mass index, selected hand anthropometric characteristics and handgrip strength in young women. Hence, physical factors such as weight, height, BMI, and hand anthropometric measurements are recommended as part of routine assessment for effective rehabilitation plans in the care of women with hand disability or poor hand function.

Abbreviations

HGS	Handgrip strength
HAC	Hand anthropometric characteristics
ArG	Arm girth
FaG	Forearm girth
WrG	Wrist girth
FSp	Finger span
FBr	Finger breath
FLg	Finger length
PLg	Palm length

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Authors' contributions

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Availability of data and materials

The datasets used and/ or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained from the Human Research and Ethics Committee (Protocol number: IPHOAU/12/897), Institute of Public Health, Obafemi Awolowo University, Ile – Ife, Nigeria. Written informed consent was obtained from all participants.

Consent for publication
Not applicable.

Competing interests
No competing interests to declare.

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