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ANTHROPOMETRIC STUDY OF HANDGRIP STRENGTH IN HAND-RELATED AND NON-HAND-RELATED ATHLETES IN KWARA, NIGERIA

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ABSTRACT

Handgrip strength (HGS) is considered an essential marker of an individual's physical strength throughout life, especially of the upper limb and fine motor function. HGS is influenced by basic anthropometric determinants such as age, stature, and gender. The information about the differences in these anthropometric parameters in athletes as compared to non-athletes and the consequent influence on HGS is scarce. Investigations of the association between involvement in hand-related and non-hand-related sporting activities among different age groups of both sexes with HGS, particularly in a developing nation like Nigeria are scarce. This study aimed to investigate how anthropometric parameters of age, height, weight, and body mass index (BMI), affect handgrip strength and their association with sport-related parameters. A cross-sectional study was conducted on 370 healthy Nigerians aged 17-40 years, from sports centres in Kwara state. Subjects were grouped into hand-athletes, non-hand-athletes, and a control group of non-athletes. A questionnaire was administered to get their biodata, while measurements of HGS(lbs); using a dynamometer, height(m), weight(kg), and BMI(kg/m^2) were taken. HGS of hand-related athletes was significantly greater than the non-hand athletes and non-athletes. No significant difference was observed between the non-hand athletes and non-athletes. HGS of the non-sportsmen was significantly correlated with age, height, weight, and BMI, however, there were no significant correlations for non-sportswomen. HGS of the non-hand-sportsmen was significantly correlated with age, weight, and BMI, but not with height, while only BMI was significantly correlated for non-hand-sportswomen. HGS of both hand-sportsmen and hand sportswomen were significantly correlated with weight and BMI, however, age and height showed no significant correlation. A strong positive correlation exists between HGS and anthropometric parameters of weight and BMI in relation to hand-related sporting activities in both sexes, but not with age and height.

KEYWORDS: Anthropometry, Handgrip Strength (HGS), Hand-Related Athlete.

INTRODUCTION

The digits of the hand allow a firm grasp of objects; known as a handgrip. Handgrip strength (HGS) is the maximum force generated by flexed fingers around an object which is voluntarily exerted by an individual under normal biokinetic conditions (1). Handgrip Strength (HGS) mainly represents the muscle strength of the upper limbs (2). HGS is considered an essential marker of an individual's physical strength throughout life, especially of the upper limb and fine motor functions (3).

HGS is influenced by basic anthropometric determinants like age, stature, and gender, but is independent of race and nationality (4). Grip strength has been accounted to show strong correlations with weight, height, and hand length, but a weak correlation with nutrition and profession (5,6).

Several studies regarding HGS have been conducted in previous research on subadults (7), while others investigated differences in HGS between the dominant and non-dominant hand (8). Previous researches have also revealed that while height and weight show a positive correlation with hand strengths at puberty, these parameters show a considerably lesser influence when compared to age and gender (3,9). Other studies revealed stronger HGS in males than in females, and

also of dominant hand compared to non-dominant hand (10). Smith et al. highlighted that the weight status of both males and females has a significant effect on HGS (11). Shurrab et al. revealed that determinants such as height, weight, and hand length are strongly correlated with HGS (12). Concerning BMI, there remains a controversy: while some studies have indicated a positive correlation with handgrip, thereby taking it to be a predictor for HGS, others discovered no significant relationship (5).

Many authors have centred on evaluating the association between age, gender, stature, hand anthropometry, and hand preference with HGS. However, the information about the differences in these anthropometric parameters in athletes as compared to non-athletes and the consequent influence on HGS is scarce. Moreover, very few studies have evaluated the relationship between involvement in hand-related and non-hand-related sporting activities among different age groups of both sexes with HGS, particularly in a developing nation like Nigeria. Based on the aforementioned, it is appropriate to establish the influence of hand-related sporting activities on handgrip strength (5), since muscle mass is an important prerequisite for muscle strength (13).

OBJECTIVES OF STUDY

We hypothesized that hand-related athletes have different handgrip strengths when compared to non-hand-related athletes and non-athletes.

This study, using non-athletes as a control group, aimed to investigate the relationship of anthropometric parameters; age, height, weight, and BMI, with HGS and their association with hand-related and non-hand-related sporting activities.

MATERIALS AND METHODS

Study design

This was a cross-sectional study conducted on 370 Nigerians comprising 250 athletes (120 males; 130 females) and 120 individuals (60 males and 60 females) who had no history of involvement in any sporting activity classified as control group. Participants were from different sports centres in Ilorin, Kwara state. Participants were sure to be healthy and within the age range of 17-40 years.

Athletes were professionals who have been involved in hand-related or non-hand-related sports for at least 3 years, while the control group comprised individuals who have no history of sport involvement but were simply spectators or there for the purpose of buying and selling. Subjects with any medical illness, anomaly, and deformity, or with a reported history of upper limb surgery, neuromuscular diseases, or musculoskeletal injuries of the upper limb were excluded.

ETHICAL APPROVAL

Ethical approval was received from the ethical review committee of the Department of Anatomy, University of Ilorin, Ilorin, Kwara state, Nigeria. All participants consented to participate in this research experiment.

DATA COLLECTION METHODS

Questionnaires were administered to collect information about demographic details (nationality, age, sex, and educational background), and sporting activity; with regards to which participants were asked how long they have been involved in the activity and also their consent. Data retrieved were grouped into tables of sports category (table 1), distribution by states (table 2), and age group stratified by sex (table 3).

Direct anthropometric measurements were also taken. This involved the use of a digital hand dynamometer to measure the grip strength, a weighing scale to measure the weight, and a meter rule to measure the height.

Subjects were orientated on the grasping procedure before the actual experiment. Each subject while comfortably seated with the elbow flexed at 90 degrees and the forearm semi-pronated (2) was told to squeeze the dynamometer as forcefully as they can afford to for three consecutive times using separate hands each time, however with a 3 minutes rest break at intervals to identify their dominant hand. The handgrip strength of the hand identified as the dominant hand was recorded (lbs).

Subjects were made to stand erect and barefooted with eyes facing forward on the weighing scale, with light clothing and no body accessories. The weight reading on the scale which was then recorded (kg).

Subjects were made to stand erect on a levelled floor with eyes facing forward against a meter rule mounted vertically on the wall. The reading was then taken with a smaller meter rule placed perpendicular to the vertical meter rule and directly above the head level of the subject. The height was recorded (m).

The BMI was computed as weight (kg)/stature (m^2).

STATISTICAL ANALYSIS

In this current study, anthropometric studies were conducted on 370 subjects. Distribution tables were generated and analysed using STATGRAPHICS, while SPSS was used for the descriptive statistics. One-way analysis of variance (Post-Hoc test of multiple comparisons) was used to determine the differences in mean values for the biometric parameters, control (non-sport participating)

population, non-hand sports population, and hand sports population. Correlation of other biometric variables to handgrip strength (HGS) of the different groups was achieved using Pearson ® correlation.

RESULTS

Presentation of results

The results presented were anthropometric measurements (hand grips, height, weight, and BMI) of adult hand-athletes, non-hand-athletes, and non-athletes of Nigerian origin. The discrete variables were presented as frequencies and percentages, while the continuous variables were presented as mean (±S.D) in tables.

SPORTS	FEMALE (%)	MALE (%)	TOTAL (%)
NON-ATHLETES	60 (16.2)	60 (16.2)	120 (32.4)
NON-HAND ATHLETE S	30 (8.1)	13 (3.5)	43 (11.6)
*BADMINTON	0 (0)	3 (0.8)	3 (0.8)
*BASKETBALL	23 (6.2)	31 (8.4)	54 (14.6)
*BOXING	0 (0)	2 (0.5)	2 (0.5)
*FOOTBALL	20 (5.4)	21 (5.7)	41 (11.1)
*GYMNASTICS	6 (1.6)	0 (0)	6 (1.6)
*HANDBALL	1 (0.3)	0 (0)	1 (0.3)
*LAWN TENNIS	1 (0.3)	2 (0.5)	3 (0.8)
*MARTIAL ART	1 (0.3)	20 (5.4)	21 (5.7)
*SWIMMING	11 (3.0)	6 (1.6)	17 (4.6)
*TABLE TENNIS	16 (4.3)	10 (2.7)	26 (7.0)
*VOLLEYBALL	21 (5.7)	12 (3.2)	33 (8.9)
TOTAL	**190 (51.4)**	**180 (48.7)**	**370**

Table 1: The distribution of the Studied Population by Sports Category.

** represent grip sports.*

The distribution of the study population by sports category in Table 1 showed that asides from the control group of non-athletes, which were 120(32.4%), non-hand athletes; 43(11.6%), basketball; 54(14.6%), football; 41(11.1%), and volleyball; 33(8.9%) were the major contributors to sportsmen and sportswomen

STATE	FEMALE (%)	MALE (%)	TOTAL (%)
ABIA	1 (0.27)	1 (0.27)	2 (0.54)
AKWA-IBOM	0 (0)	4 (1.08)	4 (1.08)
ANAMBRA	1 (0.27)	0 (0)	1 (0.27)
BENUE	4 (1.08)	0 (0)	4 (1.08)
EBOYIN	0 (0)	2 (0.54)	2 (0.54)
EDO	0 (0)	1 (0.27)	1 (0.27)
EKITI	5 (1.35)	5 (1.35)	10 (2.70)
IMO	0 (0)	1 (0.27)	1 (0.27)
KOGI	14 (3.78)	11 (2.97)	25 (6.76)
KWARA	113 (30.54)	100 (27.03)	213 (57.57)
LAGOS	6 (1.62)	10 (2.70)	16 (4.32)
OGUN	6 (1.62)	3 (0.81)	9 (2.43)
ONDO	9 (2.43)	6 (1.62)	15 (4.05)
OSUN	22 (5.95)	24 (6.49)	46 (12.43)
OYO	9 (2.43)	11 (2.97)	20 (5.41)
PLATEAU	0 (0)	1 (0.27)	1 (0.27)

Cont. Table 2: Distribution of The Studied Population by Contributions from Different States.

Table 2 showed that the major contributors to the sample population were from the southwest with Kwara state having the highest contribution (213; 57.6%).

Sex	Age group		
	<18yrs	**18-25yrs**	**>25yrs**
Male	7 (3.9)	150 (83.3)	23 (12.8)
Female	20 (10.5)	154 (81.1)	16 (8.4)
Total	**27 (7.3)**	**304 (82.2)**	**39 (10.5)**

Table 3: The Distribution of the studied Population by age groups Stratified by sex

Table 3 represented the sample distribution by age group. Age group 18-25 years represented 82.2% (males 83.3% and females 81.1%) of the study population.

The test of multiple comparisons in Table 4b showed that the mean(±S.D) hand grip strength of hand sportsmen; 73.15±19.75, was significantly greater than the non-hand sportsmen; 64.79±14.82 (P=0.024), and non-sportsmen; 64.40±15.45 (P=0.024). The difference observed between the non-hand sportsmen and non-sportsmen was not statistically significant (P=0.999). All other biometric variables were not significantly different between the groups (P>0.05).

Variable	Groups	N	Mean±S.D	Minimum	Maximum	Analysis of Variance	
						F-value	P-value
HEIGHT (m)	None	60	1.70±0.06	1.56	1.83	1.36	0.259
	Hand Sports	60	1.73±0.11	1.55	1.98		
	Non-Hand Sports	60	1.72±0.05	1.56	1.8		
	Total	**180**	**1.72±0.08**	**1.55**	**1.98**		
HGS (lb)	None	60	64.40±15.45	41.9	106.2	5.185	**0.006**
	Hand Sports	60	73.15±19.75	35.5	114		
	Non-Hand Sports	60	64.79±14.82	34.4	108		
	Total	**180**	**67.44±17.20**	**34.4**	**114**		
WEIGHT (kg)	None	60	62.83±10.77	45	90	1.849	0.16
	Hand Sports	60	64.07±7.92	47	84		
	Non-Hand Sports	60	66.05±8.81	54	91		
	Total	**180**	**64.32±9.29**	**45**	**91**		
BMI (kg/m2)	None	60	21.75±3.78	13.75	33.22	0.465	0.629
	Hand Sports	60	21.83±4.02	16.72	34.63		
	Non-Hand Sports	60	22.34±3.17	17.01	30.15		
	Total	**180**	**21.97±3.66**	**13.75**	**34.63**		

Table 4a: Descriptive Statistics and Analysis of Variance of the Biometric Parameters by Sports Category for Males.

Variables	(I) CLASS	(J) CLASS	Mean Dif. (I -J)	P-value
HEIGHT (m)	**None**	**Hand Sports**	-0.02	0.484
	Hand Sports	**Non-Hand Sports**	-0.02	0.132
		Non-Hand Sports	0.00	1.000
HGS (lb)	**None**	**Hand Sports**	-8.75	**0.024**
	Han d Sports	**Non-Hand Sports**	-0.39	0.999
		Non-Hand Sports	8.36	**0.029**
WEIGHT (kg)	**None**	**Hand Sports**	-1.23	0.855
	Hand Sports	**Non-Hand Sports**	-3.22	0.210
		Non-Hand Sports	-1.98	0.481
BMI (kg/m2)	**None**	**Hand Sports**	-0.08	0.999
	Hand Sports	**Non-Hand Sports**	-0.60	0.723
		Non-Hand Sports	-0.51	0.822

Table 4b: Post Hoc test of multiple comparisons of the mean values of the biometric parameters of the different male groups.

The test of multiple comparisons in Table 4b showed that the mean(±S.D) hand grip strength of hand sportsmen; 73.15±19.75, was significantly greater than the non-hand sportsmen; 64.79±14.82 (P=0.024), and non-sportsmen; 64.40±15.45 (P=0.024). The difference observed between the non-hand sportsmen and non-sportsmen was not statistically significant (P=0.999). All other biometric variables were not significantly different between the groups (P>0.05).

Variable	Groups	N	Mean±S.D	Minimum	Maximum	Analysis of Variance	
						F-value	P-value
HEIGHT (m)	None	60	1.65±0.06	1.52	1.77	6.146	**0.003**
	Hand Sports	62	1.69±0.06	1.55	1.83		
	Non-Hand Sports	68	1.68±0.07	1.52	1.89		
	Total	**190**	**1.68±0.07**	**1.52**	**1.89**		
HGS (lb)	None	60	46.11±11.49	28.70	82.10	16.438	**0.000**
	Hand Sports	62	58.3±12.27	34.70	85.00		
	Non-Hand Sports	68	49.99±12.29	20.60	80.50		
	Total	**190**	**51.48±12.98**	**20.60**	**85.00**		
WEIGHT (kg)	None	60	57.55±8.21	45.00	81.00	2.739	0.067
	Hand Sports	62	58.50±9.08	42.00	92.00		
	Non-Hand Sports	68	55.10±8.40	43.00	79.00		
	Total	**190**	**56.98±8.65**	**42.00**	**92.00**		
BMI (kg/m2)	None	60	21.09±2.91	15.57	29.53	4.630	**0.011**
	Hand Sports	62	20.49±3.22	14.76	29.89		
	Non-Hand Sports	68	19.53±2.71	14.40	27.04		
	Total	**190**	**20.34±3.00**	**14.40**	**29.89**		

Table 5a: Descriptive statistics and analysis of variance of the biometric parameters by sports category for females.

Variables	(I) CLASS	(J) CLASS	Mean Dif. (I -J)	P-value
HEIGHT (m)	**None**	**Hand Sports**	-0.039	**0.002**
		Non -Hand Sports	-0.027	**0.044**
	Hand Sports	**Non -Hand Sports**	0.012	0.658
HGS (lb)	**None**	**Hand Sports**	-12.187	**0.000**
		Non -Hand Sports	-3.875	0.189
	Hand Sports	**Non -Hand Sports**	8.311	**0.001**
WEIGHT (kg)	**None**	**Hand Sports**	-0.950	0.905
		Non -Hand Sports	2.447	0.266
	Hand Sports	**Non -Hand Sports**	3.397	0.085
BMI (kg/m2)	**None**	**Hand Sports**	0.599	0.629
		Non -Hand Sports	1.565	**0.006**
	Hand Sports	**Non -Hand Sports**	0.966	0.189

Table 5b: Post Hoc test of multiple comparisons of the mean values of the biometric parameters of the different female groups.

The test of multiple comparisons in Table 5b showed that the mean(±S.D) height and HGS of hand sportsmen (height; P=0.002 and HGS; P<0.001) was significantly greater than the non-sportsmen. Also, while the mean(±S.D) height of non-hand sportsmen (P=0.044) was significantly greater than the non-sportsmen, there was no significant difference in their HGS. However, the mean(±S.D) HGS was significantly lower in non-hand sportsmen than in hand sportsmen (P=0.001). No significant difference was observed for the weights of the three groups (P=0.999); however, the BMI of the non-hand sportswomen was significantly lower than the non-sportswomen (P=0.006).36

Vari ables	correlation with HGS (lb) in males			correlation with HGS (lb) in females		
	r	R^2	P-value	*r*	R^2	P-value
AGE (yrs)	0.717	51.4%	**0.000**	0.251	6.3%	0.053
HEIGHT (m)	0.312	9.7%	**0.015**	0.195	3.8%	0.135
WEIGHT (kg)	0.536	28.7%	**0.000**	0.144	2.1%	0.271
BMI (kg/m 2)	0.398	15.8%	**0.002**	0.047	0.2%	0.719

Table 6: Sex-specific correlation of biometric parameters to hand grip strength (HGS) of non-sports participating population.

Note: *r=Pearson's coefficient, R^2= Coefficient of determination;*

Table 6: showed that the HGS of the non-sportsmen were significantly correlated with age (r=0.717; P<0.001), height (r=0.312; P=0.015), weight (r=0.536; P<0.001), and BMI (r=0.398; P=0.002); however, there were no significant correlations (P>0.05) for non-sportswomen.

Variables	correlation with HGS (lb) in males			correlation with HGS (lb) in females		
	r	R^2	P-value	*r*	R^2	P-value
AGE (yrs)	0.379	14.4%	**0.003**	-0.031	0.1%	0.803
HEIGHT (m)	0.043	0.2%	0.743	-0.093	0.9%	0.452
WEIGHT (kg)	0.486	23.6%	**0.000**	0.195	3.8%	0.111
BMI (kg/m2)	0.455	20.7%	**0.000**	0.272	7.4%	**0.025**

Table 7: Sex-specific correlation of biometric parameters to hand grip strength (HGS) of non-hand sports participating population.

Note: *r=Pearson's coefficient, R^2= Coefficient of determination*

Table 7 showed that the HGS of the non-hand sportsmen were significantly correlated with age (r=0.379; P=0.003), weight (r=0.486; P<0.001), and BMI (r=0.455; P<0.001), but not with height (r=0.043; P=0.743); however, for non-hand sportswomen, only BMI was significantly correlated (r=0.272; P<0.05).

Variables	correlation with HGS (lb) in males			correlation with HGS (lb) in females		
	r	R^2	P-value	*r*	R^2	P-value
AGE (yrs)	0.14	2.0%	0.286	-0.059	0.3%	0.648
HEIGHT (m)	-0.065	0.4%	0.621	0.117	1.4%	0.364
WEIGHT (kg)	0.339	11.5%	**0.008**	0.393	15.4%	**0.002**
BMI (kg/m2)	0.285	8.1%	**0.028**	0.339	11.5%	**0.007**

Table 8: Sex-specific correlation of biometric parameters to hand grip strength (HGS) of hand sports participating population

Note:*r=Pearson's coefficient, R^2= Coefficient of determination.*

Table 8 showed that the HGS of both hand sportsmen and hand sportswomen were significantly correlated with weight (r=0.339; P=0.008); (r=0.393; P=0.002), and BMI (r=0.285; P=0.028); (r=0.339; P=0.007). However, age and height showed no significant correlation (P>0.05).

DISCUSSION

This present study was aimed at analysing the relationship of anthropometric characteristics of age, height, weight, and BMI with HGS and their association with hand-related and non-hand-related sports involvement. The HGS of hand-related athletes and non-hand-related athletes of both sexes have been determined and compared with the non-athlete control group.

The result revealed that the HGS of both males (73.15±19.75) and females (58.3±12.27) involved in hand-related sports was significantly greater ($P<0.05$ in males; $P<0.001$ in females) than that of those involved in non-hand-related sports (male;64.79±14.82, female;49.99±12.29) and non-athletes (male;64.40±15.45, female;46.11±11.49). The difference between the HGS values of both males and females involved in non-hand-related sports and the control group (non-athletes) was statistically not significant ($P>0.05$). This result established a direct positive correlation between hand-related sporting activities and HGS, while involvement in non-hand-related sports does not necessarily influence HGS. This is in agreement with similar kinds of studies conducted on different populations (14,15,16). Also, grip strength showed significant differences between sexes.

Previous studies have established that age, gender, and anthropometric traits which are strongly associated with changes in muscle mass (17) were the influencing factors of handgrip strength (17,18). Baskaran et al. discovered a strong correlation between age, height, and weight with HGS in both sexes (19).

This study however revealed that, while males generally showed a significant relationship between HGS and anthropometric parameters of age, height, weight, and BMI ($P<0.05$), non-sports females showed no significant correlation ($P>0.05$). It should be noted however that, males involved in hand-related sporting activities showed no significant influence of age and height on HGS. A possible explanation is that the increased muscle mass in the upper limb as a result of the consistent physical activity of the hand makes up for the aging effect, hence advancing age does not directly affect HGS in these groups of athletes that fall within the age range of this study. Also, the result revealed that females participating in hand-related sports showed a significant positive relationship between weight, BMI, and HGS as opposed to non-sports women.

The results of this study have also established an association between hand-related sporting activities and anthropometric parameters of weight and BMI, as well as their effect on HGS. Except in non-sports females (the control group), BMI is shown to have the most consistent and positive significant correlation with HGS among the anthropometric parameters studied.

Based on the results of this study, age, and height showed no significant correlation with HGS in females and remained insignificant even with involvement in any kind of sports. Height was only significantly correlated with HGS in non-sporting males (the control group) but showed no significant correlation in sportsmen generally.

CONCLUSION

Hand-related athletes demonstrated higher HGS compared to non-hand-related athletes and non-athletes. A strong positive correlation exists between handgrip strength and anthropometric parameters of weight and BMI in relation to hand-related sporting activities in both males and females, but not with age and height.

RECOMMENDATION

It is strongly recommended that further research using a larger sample size and having more data for each age group, especially the older age group, should be conducted to corroborate the findings of this research and similar researches be carried out among other populations.

CONTRIBUTION TO KNOWLEDGE

The findings of this study have tremendous practical implementation in the identification of talents in sports like volleyball, basketball, and handball. It would help athletes to optimize training programs for certain sports like boxing, wrestling, martial arts, and judo (8). Also provides a useful guide to health professionals in clinical applications such as hand rehabilitation, determining treatment efficacy of pathological conditions such as in rheumatoid arthritis, and recovery exercises after trauma or a surgical procedure (13).

CONFLICT OF INTEREST

No conflict of interest.

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