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Sex Variation in Digit Length and Hand Grip Strength among Selected Secondary School Students in Kano, Nigeria

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Abstract

Hand grip strength (HGS) is one of the anthropometric hand parameters that is affected by many factors including sex, age and body dimension. The aim of the study was to determine variation in digit length and hand grip strength among selected secondary school students in Kano, Nigeria. A total of eight hundred participants (400 males and 400 females) were considered for the study. The measurement of the HGS of right and left hands were carried out using digital hand grip dynamometer at sitting position. Second to fourth digit ratio (2D:4D) was obtained from the measured digit length using digital Vernier caliper. Descriptive statistics (mean ± standard deviation) was used to express the data and independent sample t-test was used for the comparison between sexes. The data was analyzed using SPSS (IMB, corporation, NY) version 20 and statistical significance was declared at P<0.05. The results indicated significance difference in digit length and HGS with male having higher mean value than their female counterparts in all the three age groups. Sex variation was also observed with respect to 2D:4D across the age groups with females having higher ratio compared to males in both left and right hands. In conclusion, male exhibited higher mean HGS and digit length while female tend to have higher mean value of 2D:4D irrespective of three age spectra.

Keywords: Age, sex variation, 2D:4D, hand grip strength, Hausa Lineage

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INTRODUCTION

The human hand is a distinctive part of the body characterized with high tactile sensation and manipulation activities. The hand have been used as a tool, symbol, weapon and also known to function in artistic activities, as it is designed for grasping and precise movements' necessary for creative endeavors (Kanchan and Krishan, 2011; Barut and Demirel, 2012). The hand dimension is crucial for its function (White, 1980). It is observed that while doing activities of daily living by hand, the force projected by the hand and digits depends relatively on the hand elements and digit length (Chroni*et al*., 2001; Boz et *al*., 2004).

In human sexual dimorphism have been described (Frayer and Wolpoff, 1985; Pheasant, 2003), including those sex variation related to the digit length (Boz *et al*., 2004; Buffa *et al*., 2007; Kanchan and Krishan, 2011; Kanchan and Rastogi, 2009). It was shown that individual population or ethnic group has varied in anthropometric characteristics of the hand and upper extremity (Gnaneswaran and Bishu, 2011). Previous study reported significant differences in both right and left digit length and hand grip strength (HGS) values among female handball, volleyball and basketball players (Colak, 1995). Research also has demonstrated prominent sex variations in HGS of adult populations, with males having higher values than there female counterpart (Kamarul *et al.*, 2006; Mathiowetz *et al.*, 1985). The study of Danborno *et al.,* (2008) on Nigerians also demonstrated sex variation in second digit (2D), fourth digit (4D) and 2D:4D. The sexual dimorphic nature of the 2D:4D was link to its correlation with *in utero* testosterone levels (Manning *et al*., 1998; Manning and Taylor, 2001).

For many games, volley ball, basketball etc. that required manual function, hand morphology and grip strength may be of functional significance for effective performance. Therefore, reference data on various forms of HGS and2D, 4D, 2D:4Dmay be of paramount importance in solving problems associated with hand games and injuries. The reliable and valid evaluation of HGS and 2D, 4D, 2D:4D may also be of paramount importance in determining the effectiveness of various hand surgical and treatment procedures. The HGS may be use as functional index of nutritional status of an individual. Also 2D, 4D and 2D:4D can be used for the designing of suitable hand tools, orthotics, and gloves for the Hausa population. Considering the various application of hand dimension (2D, 4D, 2D:4D) and HGS as well as age, sex and ethnic specific variation of these variable, the presence study was conducted to determine the sex variation in HGS and some hand dimensions (2D, 4D and 2D:4D) across three different age spectra of Hausas lineage of Kano State metropolis of Nigeria.

MATERIALS AND METHODS

Study location

The study was carried out in Kano metropolis of Nigeria. Geographically Kano is situated between latitude 12.2^{o} North and longitude 9.4^{o} East. Hausa is the lingua franca, but English is the official language. Kano city is the capital of the state in Northwestern Nigeria. Its metropolitan population is the second largest in Nigeria aside of Lagos. The area of Kano urban covers 137 km^2 and includes six Local Government Area (LGAs) - Kano Municipal, Fagge, Dala, Gwale, Tarauni and Nassarawa - with a population of 2,163,225 according to 2006 Nigerian census. The area covered by metropolitan part of Kano is 499 km^2 and includes eight LGAs - the six mentioned above together with Ungogo and Kumbotso make up population of 2,828,861 according to 2006 Nigerian census (NPC/FGN, 2006). The dominant tribe of the city is Hausa which are the most dominant in Northern part of Nigeria (Dan-Asabe, 2000).

Sampling collection

Sampling was done at random. The stratified sampling technique was used to collect data from twelve selected secondary schools in Kano metropolis. The sample size for this study

was 800 subjects comprising of 400 male and 400 female students from selected secondary schools of the metropolis. The inclusion criteria were no constraint of movement, decrease joint range of motion, history of any inflammatory joint disease, neurological disorder or injury to the upper or lower extremity by self-reports. All the subjects were apparently healthy and within the age range of 15 to 20 were included in the study. The participants were grouped into 15-16, 17-18 and 19-20 age groups. However, any subject with congenital deformities diseases or injuries in the hands and body parts. Any participant outside the age range and also anyone who did not sign the consent form, were excluded from the study. Simple Proforma was used to collect the biodata; age, sex and ethnicity of the participants. Ethical clearance as issued from the ethical committee of Kano State Hospital Management Board. Introduction letter was used to seek for permission at selected secondary schools in Kano metropolis.

Digit Anthropometry, ratio and HGS measurement

The following hand dimension was measured as proposed by Manning *et al*. (1998) using digital Vernier caliper. Length of second digit (2D): Perpendicular distance from the tip of the 2nd digit (D2) to ventral proximal crease. Length of fourth digit (4D): Perpendicular distance from the tip of the 4th digit (D4) to ventral proximal crease. The 2D:4D was derived as the length of 2D divide by that of 4D. The grip strength of right and left hands were measured using a regular digital hand grip dynamometer (Model EH101, Camry, China) at sitting position with shoulder in adduction and neutral rotation whereas elbow is placed in full extension. The subjects were asked to apply maximum voluntary force on digital hand held dynamometer using both dominant and non-dominant hands (Koley et *al.,* 2011). The mean value was recorded to the nearest 0.1kg.

Statistical Analyses

Descriptive statistics (mean ± standard deviation) was used to express the data. Comparisons of HGS, digit length and ratio between sexes were carried out using student's t-test. Data were analyzed using SPSS version 20 (IBM Corporation, NY). Statistical significance was declared at $P < 0.05$.

RESULTS

Tables 1 shows sex variation in right hand grip strength, second and fourth digit length among Hausa population. A significant difference ($P<0.001$) was observed in right HGS between male and females with male having HGS than their female counterpart in all the three-age group with the magnitude of sex variation higher in old age groups. Males exhibited higher mean values in 2D and 4D length in all the age categories. From Table 2, a significant difference ($P = 0.001$) in left HGS and digit length (2D and 4D) were observed similar to the right side.

Table 1: Sex variation in right hand grip strength and digit length among Hausa students' population in Kano

Right hand		Male	Female		
Age group	Variables	Mean ± SD	Mean ± SD	t	P
15 -16	Hand grip strength (kg)	31.97 ± 10.12	20.98 ± 5.68	5.54	< 0.001
	Second digit length (mm)	69.37 ± 5.30	65.61 ± 5.07	3.33	0.001
	Fourth digit length (mm)	71.76 ± 5.41	65.70 ± 5.31	5.52	< 0.001
17 -18	Hand grip strength (Kg)	35.12 ± 7.69	20.79 ± 4.98	21.56	< 0.001
	Second digit length (mm)	71.32 ± 5.96	66.85 ± 5.41	7.47	< 0.001
	Fourth digit length (mm)	73.82 ± 5.71	66.24 ± 5.27	13.11	< 0.001
19 -20	Hand grip strength (mm)	40.17 ± 7.75	20.61 ± 4.78	23.68	< 0.001
	Second digit length (mm)	73.42 ± 4.66	67.57 ± 5.10	9.05	< 0.001
	Fourth digit length (mm)	75.02 ± 5.11	66.71 ± 5.04	12.46	< 0.001

Table 2: Sex variation in left hand grip strength, and digit length among Hausa students' population in Kano

Left hand		Male (n= 82)	Female (n= 29)		
Age group	Variables	Mean ± SD	Mean ± SD	t	P
15 -16	Hand grip strength (kg)	30.99 ± 9.53	17.75 ± 5.99	7.00	< 0.001
	Second digit length (mm)	69.85 ± 6.39	66.04 ± 5.59	2.85	0.005
	Fourth digit length (mm)	71.95 ± 5.22	65.78 ± 6.26	5.20	< 0.001
17 -18	Hand grip strength (kg)	34.17± 7.93	17.91 ± 5.09	23.80	< 0.001
	Second digit length (mm)	71.64 ± 5.14	67.39 ± 5.85	7.20	< 0.001
	Fourth digit length (mm)	74.53 ± 5.41	65.70 ± 5.14	15.85	< 0.001
19 -20	Hand grip strength (mm)	38.51 ± 7.66	18.55 ± 5.39	23.35	< 0.001
	Second digit length (mm)	73.52 ± 4.67	68.03 ± 5.29	8.30	< 0.001
	Fourth digit length (mm)	75.99 ± 5.26	66.16 ± 5.22	14.26	< 0.001

Figure 1 shows sex variation in 2D:4D across different age categories. It was observed that in all the three age groups female participants tend to have significantly (P<0.05) higher mean value compared to the male counter parts in both right and left hands.

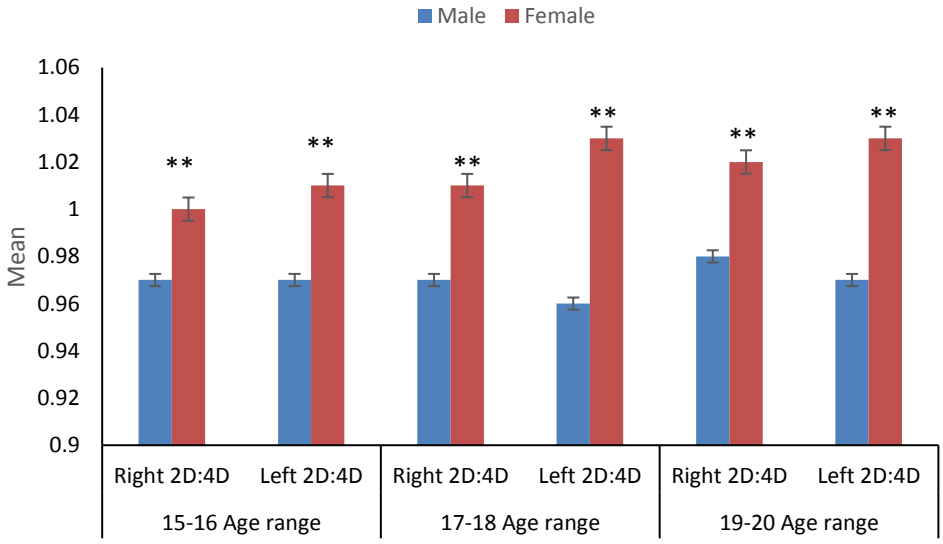

Figure 1: Sex variation in 2D:4D across different age categories, **p< 0.05

DISCUSSIONS

Variations exist in different hand measurements across different ethnic groups (Okunribido, 2000). Population differences in hand parameters have been observed and recommended that each population to be studied differently (Aboul-Hagag *et al.*, 2011). However, the sex variation in HGS and 2D, 4D, 2D:4D received less attention among the Hausa population in Kano state. Therefore, the present study seeks to determine the existence of sex variation in HGS and 2D, 4D, 2D:4D with specific reference to three age groups.

A significantly higher mean HGS observed in male is in line with previous studies which suggested that HGS in healthy individuals is age and sex specific (Mathiowetz *et al.*, 1985; Harkonen *et al.*, 1993; Chong *et al.*, 1994). A remarkable sex variation in HGS among adult populations, with male far outscoring female has also been reported (Mathiowetz *et al.*, 1985; Kamarul*et al.*, 2006; Bohannon *et al.*, 2006; Shetty *et al.*, 2012; Hemberal *et al.*, 2014). Testosterone, which is known to be higher in males, was suggested to be one of the factors that positively influenced the hand grip strength as study have shown that males with low

testosterone levels due to androgen deprivation have low grip strength (Soyupek*et al*., 2008). On other hand an extra increase in testosterone enhance HGS in elderly males with low serum testosterone (Sih*et al*., 1997; Wang *et al*., 2000; Page *et al*., 2005).Moreover, somatic sex variation in mammals to presence have been found to be as a result of either androgenic masculinisation or effects of the sex chromosomes (Fink *et al*., 2006). Increased bone mineral density and muscle mass in males compared to their opposite sex is also another factor that have been shown to influences the HGS (Hemberal *et al*., 2014).

Indeed, sex variation have also been noticed in the forebrain and cardiac sympathetic nervous responses at the onset of handgrip exercise (Wang *et al*., 2010), with little cardiovascular response (heart rate and mean arterial pressure) and weaker insular cortex activation seen in the females. Interestingly, this may reveal both physiological and psychological sex variation when requested to provide a maximum squeeze of a dynamometer. While greater height, weight, and muscle mass in males has been submitted as an explanation for this effect (Kamarul*et al*., 2006; Kuh, *et al*., 2006). In addition to the previous reasons reported in the literature, the current research also hypothesised that differences in life style in community may also explain the HGS in males. For example, the exposure of male to the more manual work than the female counterpart may leads to sexual dimorphism in HGS. Moreover, the more manual work exposure the higher the musculature, hence the higher the HGS.

The results of sex variation in 2D, 4D and 2D:4D in the present study agrees with the study of Danborno *et al.,* (2008) on Nigerian population. Significantly higher digit length and lower 2D:4D found in male is linked to high levels of testosterone. The 2D:4D have been described to have negative correlation with testosterone levels and positive association with oestrogen levels in adults (Manning *et al*., 1998; Manning and Taylor, 2001). Hönekopp and Schuster (2010) carried out a meta-analytic review consisting of 25 previously published studies and establish that 2D:4D ratios were significantly negatively correlated with physical prowess (strength, endurance, or both). The lower 2D:4D in males as marker of high testosterone is supported by higher HGS which also additional marker of the testosterone. The two variables can therefore be used as a measure of testosterone by proxy in the present study population.
Age is one of the confounding variable in most of the anthropological studies a such categorization of individuals according to different age groups is always important for making some generalized conclusion. The present result shows that among all the three age spectra, there are significant sex variation in HGS and 2D, 4D and 2D:4D. The magnitude of the sexual dimorphism was higher in old age group. In support of this observation, it was earlier been reported that the pattern of growth in the limbs are essentially linear through late adolescence but conclude earlier in the female than the male (Hiernaux, 1968). Therefore, this indicated that earlier conclusion of growth in female will allow more exhibition of sexual dimorphism in adults compared to earlier ages. This may indirectly lead to the suggestion that effect of sex hormones such testosterone on the body structures including digits are age sensitive.

The estimation of 2D:4D and HGS are also of huge significance in determining the efficacy of many treatment strategies of hand rehabilitation. The reliability and valid evaluation of HGS can be of paramount advantage in determining the effectiveness of various surgical and treatment procedure. However, the assessment of HGS may be of significance in the evaluation and follow up of patients with neuromuscular disease. Many exercises in gyms and fitness centres across the country indirectly work on individuals' grip. Other exercises such as dead lifts, bent over rows among others also depend upon the athlete's level of grip

strength therefore data on 2D:4D and HGS can be used in assessing sex variation in sport performances of different age spectra among Hausa lineage of Nigeria.

CONCLUSION

In conclusion, the results of the present study show significant sexual variation in HGS and 2D, 4D and 2D:4D. Males had higher mean HGS and digit length but lower 2D:4D than the females in both left and right hands across all the three different age spectra among Hausa population of Kano state Nigeria.

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