

RESEARCH ARTICLE

Relationship between Second to Fourth Digit Ratio (2d:4d) with Body Mass Index and Waist to Hip Ratio among Hausa Ethnic Students in Yusuf Maitama Sule University

¹Isyaku Ibrahim, ¹Hauwa`u Ibrahim Abdullahi, ^{2,3}Mikail Isyaku Umar, ¹Hamza Garba Adamu, ¹Saleh Nuhu

¹Department of Human Anatomy, Yusuf Maitama Sule University, Kano Nigeria ²Department of Human Anatomy, Federal University Dutse, Jigawa State Nigeria ³Department of Anatomy, Kampala International University, Uganda.

Abstract

Background: The relative of the 2nd and 4th digits lengths (2D:4D) is a sexually dimorphic trait in which males have an affinity to have shorter 2nd digits relative to 4th digits than females. This shows that digit ratio (2D:4D) is a standby marker of prenatal testosterone. The aim of the present study is to determine the relationship between second to fourth digit ratio (2D:4D) with Body Mass Index (BMI) and Waist to Hip Ratio (WHR). **Methods:** Three hundred (300) subjects were selected from all the faculties in Yusuf Maitama Sule University Kano, using simple random sampling technique. The lengths of the 2nd and 4th digits were determined using a digital vernier caliper. Height and weight were measured using stadiometer and weighing scale respectively. BMI and WHR were computed. The data were expressed as mean \pm SD. Independent-samples t-test was used to determine the sexual dimorphisms between male and female and Pearson correlation was used to quantify the relationships between the study parameters. **Results:** The present study shows significant ($P < 0.05$) differences between the sex in the right and left digit length, height and weight. However, there are no significant ($P > 0.05$) differences between the sex in the digit ratio, waist circumference, hip circumference and waist to hip ratio. On correlation, it was noted that there was no significant correlation between both right and left 2D: 4D with BMI. However, it is found that digit length correlates positively with height and weight and there is a significant negative correlation between 2D:4DL with waist to hip ratio (WHR). **Conclusion:** There is also no correlation between 2D:4DR and WHR. However, it is observed that there is no significant correlation between BMI and WHR. But BMI shows significant positive correlation with waist circumference and hip circumference.

Keywords: Body Mass Index, Hausa ethnic group, Second to Fourth Digit Ratio and Waist to Hip Ratio

Introduction

The ratio of the index finger (2D) and ring finger (4D) lengths is expressed as the 2D:4D (Oyeyemi *et al.*, 2014). The relative of the 2nd and 4th digits lengths (2D:4D) is a sexually dimorphic trait in which males have an affinity to have shorter 2nd digits relative to 4th digits than females. This shows that digit ratio (2D:4D) is a standby marker of prenatal testosterone (Manning *et al.*, 1998).

Previous study reported that the 2D:4D digit ratio in relation to physical performance, sports, and psychological characteristics like assertiveness and

aggression as well as on muscle strength (Canan *et al.*, 2018). A research between 2D:4D and neck circumference on body composition indicators reports that men with higher 2D:4D are at greater risk of obesity and heart disease (Han *et al.*, 2016). A study on the relationship between facial masculinity and digit ratio reports no significant correlation between the 2D:4D with indices of masculinity (Ibrahim *et al.*, 2023). Studies report that 2D:4D is related to several medical conditions including cardiovascular diseases (CVD), obesity and metabolic syndrome. Without exclusions, the prevalence of metabolic syndrome

appears to have increased in parallel to the prevalence of obesity in the past 20 years, according to the world Nutrition and Health Survey (Hwang *et al.*, 2006). Hence, high priority is needed to have a comprehensive understanding of metabolic syndrome in overweight and obese people in our population, so that it will help our managements for the prevention strategies. A strong association is testified between 2D:4D and higher concentrations of triglycerides. 2D:4D is suggested as a tool to determine the risk of metabolic syndrome (White *et al.*, 2017).

The sex-hormone profile of an individual is the main reason for the constancy of sexual dimorphism of the subsequent body parameters, such as body mass index (BMI), waist-to-hip ratio (WHR) and waist-to-chest ratio (WCR). For the above reasons, low WHR in women is typically associated with high levels of circulating oestrogens, whereas high WHR is correlated with high levels of circulating testosterone (Evans *et al.*, 1983). WHR in females appears to be directly linked to health and fertility as it has been shown to be an accurate predictor of risk for various diseases (Abbott *et al.*, 2002). Furthermore, females with best WHR produce more offsprings and become pregnant more quickly when they receive artificial insemination (Singh and Zambarano 1997).

BMI cannot assess the distribution of body fatness, and the adverse consequences of obesity may be most strongly associated with the amount of visceral fat. Therefore, in addition to the body mass index (BMI), the waist circumference (WC) has been reflected to be a valuable measurement, effective for assessing body fat distribution and connected cardiovascular risk and mortality additional advantage simple and inexpensive during measurement (Bales *et al.*, 2008).

Obesity is one of the main risk factors for chronic diseases. Worldwide, obesity has become a leading global health problem owing to its strong association with a high incidence of diseases like heart diseases and oxidative stress complications. Studies on the genetics of obesity have generally been performed on twins, as it was considered that the body mass index (BMI) may be transmitted through genetic inheritance. However, another thing that can be transmitted by genetic inheritance is finger length ratio (2D:4D). It has been observed that 2D:4D is negatively related to prenatal testosterone and

is positively associated with prenatal estrogen, where testosterone has been reported to be protective against heart disease, obesity, and metabolic syndrome, depression, and anxiety (Bailey *et al.*, 2005). Literature review also reports a bidirectional relationship between testosterone and obesity. Earlier studies reported variations of 2D:4D in different ethnic and geographic groups. Previous studies have also shown that high waist to hip ratio is significantly related to obesity. With the increase of prevalence of obesity: The World Health Organization (WHO) has estimated that in 2014, 11% of men and 15% of women aged 18 years and above were obese, while another 38% of men and 40% of women were overweight. In Nigeria, the prevalence of overweight individuals ranges from 20.3% to 35.1%, while the prevalence of obesity ranges from 8.1% to 22.2%. Although the etiology of obesity is complex, dietary factors, particularly the consumption of high caloric diet coupled with physical inactivity, are considered as major risk factors for its development. However, with aforementioned troublesome risk factors, there are limited studies that have been carried out to investigate the influence of the correlations between second to fourth digit ratio (2D:4D) and its relationship with body mass index (BMI) and waist to hip ratio (WHR) in our society. Moreover, the ability of body mass index (BMI) and waist to hip ratio (WHR) in prediction of 2D:4D among various ethnic groups receives less attention. However, since health measures (e.g. waist circumference, hip circumference, waist to hip ratio weight, height and body mass index) were the biometrics collected, the analyses of the study would indicate how physically fit the studied population are in their challenging environment. The aim of the present study is to determine the correlations between second to fourth digit ratio (2D:4D) between body mass index (BMI) and waist to hip ratio (WHR).

Materials and Methods

The Study Area

The present research was conducted among a group of Hausa ethnic students in Yusuf Maitama Sule University which is one of the three public universities in Kano State, Nigeria. The University is located within Kano metropolis along Kabuga-Kofar Ruwa market road, in Dala Local Government. It has five faculties including the faculty of basic medical science and thirty-five different departments.

The Study Design

The present research was a prospective cross-sectional study.

Sample Size Determination

Sample size was determined using the formula developed by Cochran (Cochran, 1977) as shown below;

$$n = \frac{z^2 pq}{d^2}$$

Where

n = desired sample size

Z = confidence level (how confident the actual mean falls within your confidence interval) 1.96 at 95%

p = prevalence/proportion of standard deviation (how much variance is expected in the responses) 3.45/30.59 = 0.11

q = 1 – p,

d = degree of precision/ margin of error which is 5%.

$$n = \frac{z^2 pq}{d^2} = \frac{(1.96)^2 \times 0.11 \times (1 - 0.11)}{(0.05)^2} = 150$$

Therefore, minimum sample size needed for the study was 150

The Study Population The study population is made up of Hausa undergraduate male and female students of Yusuf Maitama Sule University Kano, Nigeria. Three

hundred and two (302) subjects were selected from various faculties of the University, using random sampling methods. The age range of the participants is between 18-50 years. Participants who reported any clear deformity or limb abnormality were not included in the study. Likewise, non-Hausa ethnic groups and non-student of Yusuf Maitama Sule University Kano, Nigeria were not included in the study. Before the beginning of the research, ethical approval was sought from the Ethical Committee of the College of Health Science of Yusuf Maitama Sule University Kano, Nigeria Kano before the beginning of the research, Informed consents were sought from the participants.

Anthropometric Measurements

Measurements of the Second and Fourth Digit Lengths and Determination of 2d: 4d

The lengths of the second to fourth (2nd and 4th) digits were determined using a direct technique of measurement (Manning & Taylor, 2001, Ibrahim *et al.*, 2023, Ibrahim *et al.*, 2024), the observers were asked to take out rings and the lengths of the 2nd and 4th digits were measured directly (using vernier calliper accurate to 0.01 mm) on the ventral surfaces of both right and left hands from the basal crease of the digit to its tip. Each digit was measured twice and the average was taken. When there was a gang of creases at the base of the digit, the most proximal crease was measured. Digit lengths (2d:4d) measured (in mm) were computed for determination of the 2D: 4D by dividing the 2nd digit length by the 4th digit length (Plates 1).

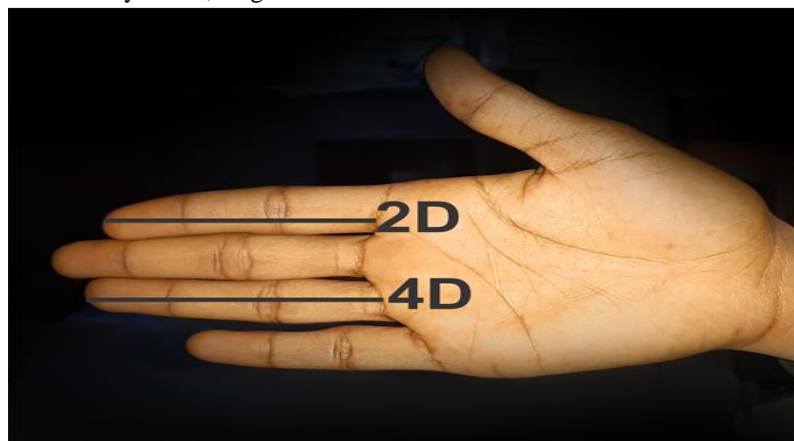


Plate 1: Landmarks for Measurement of 2D and 4D

Measurement of Height, Weight and Determination of Body Mass Index

For each participant whose height and weight were both measured using stadiometer and digital weighing scale respectively, body mass index (BMI) was calculated by dividing weight in kilograms over square height in meters. The result is expressed in kg/m².

Measurement of Waist Circumference, Hip Circumference and Determination of Waist to Hip Ratio

Stand up straight and breathe out, then measure the distance around the largest part of your hips and the widest part of your buttocks. Each participant was measured using a tape measure. In accordance with ethical guidelines, a female investigator took measurements of the female participants, and a male investigator took measurements of the male participants. Calculate the WHR by dividing your waist circumference by your hip circumference.

Statistical Analyses

The data were expressed as mean ± SD. Independent-samples t-test was used to determine the sexual dimorphisms between the male and the female participants. Also, Pearson correlation was used to quantify the relationships between the study parameters. The SPSS version 20 was used to carry out the analyses. P < 0.05 was considered as level significance.

Results

Table 1 shows descriptive statistics of age, digit lengths, digit ratio, body mass index (BMI) and waist -to hip ratio (WHR) of the study population. The mean value for the age of participants was 21.90±2.41. The mean value for the 2DRight was 68.99±4.71mm, lower than the 4DRight, which was 72.79±4.95mm, similar to the left digit. The mean value of 2D: 4DR was 0.95±0.04 which was lower than 2D: 4DL with mean value of 0.96±0.48. For the BMI, the average mean value was 19.63±3.28 and the average value for the WHR was 0.88±0.061.

Table 2 shows the sexual dimorphism of the study variables. It was observed that there were significant (P <0.05) differences between the right and left digit length, height, weight and WHR between the participants. However, there were no significant (P >0.05) differences between all the digit ratio, waist circumference, hip circumference and BMI.

Table 3 shows Pearson’s correlation between digit length and ratios with height, weight and BMI. It was observed that there were no significant correlations between both the right and the left 2D: 4D with BMI. However, it was found that all the digit length correlated positively with height and weight.

Table 4 shows Pearson’s correlation between digit length and ratios with waist circumference, hip circumference and waist to hip ratio. It was observed that there was significant negative correlation between 2D:4DL with waist to hip ratio (WHR). For the 2D:4DR, no correlation was observed with WHR.

Table 1: Descriptive Statistics of Age, Digit Lengths, Digit Ratio, Body Mass Index (BMI) and Waist -to Hip Ratio (WHR).

Variables	N	Minimum	Maximum	Mean ± SD
AGE	(300)	17	33	21.90±2.41
2DR	(300)	57	83	68.99±4.71
4DR	(300)	56	89	72.79±4.95
2D:4DR	(300)	0.85	1.10	0.95±0.04
2DL	(300)	55	85	69.71±5.51
4DL	(300)	60	83	72.74±5.51
2D:4DL	(300)	0.86	1.16	0.96±0.48
HEIGHT SQUARE	(300)	1.96	3.69	2.75±0.28
WEIGHT	(300)	30	81	53.86±9.67
BMI	(300)	10.76	30.71	19.63±3.28
WC	(300)	24	38	31.19±2.90
HC	(300)	29	44	35.41±3.04
WHR	(300)	0.74	1.12	0.88±0.06

2DR: second right digit length, 4DR: fourth right digit length, 2D:4D: digit ratio, BMI: body mass index, WC: waist circumference, HC: hip circumference, WHR: waist -to hip ratio

Table 2: Sexual Dimorphism of the Digit Lengths, Digit Ratio, Body Mass Index (BMI) and Waist -to Hip Ratio (WHR) of the Study Population

Variables	Gender	N	Mean±SD	t-value	p-value
2DR	Male	150	70.91±4.46	5.74	<0.001
	Female	150	66.90±4.06		
4DR	Male	150	74.37±5.03	5.81	<0.001
	Female	150	69.86±4.42		
2D:4D	Male	150	0.96±0.06	-.27	0.787
	Female	150	0.96±0.05		
2DL	Male	150	71.68±5.39	4.90	<0.001
	Female	150	67.57±4.85		
4DL	Male	150	75.18±4.45	7.31	<0.001
	Female	150	69.69±4.73		
2D:4DL	Male	150	0.96±10.98	0.95	0.345
	Female	150	0.97±0.048		
HEIGHT	Male	150	170.42±7.93	8.61	<0.001
	Female	150	160.53±5.90		
WEIGHT	Male	150	56.42±8.27	3.51	0.001
	Female	150	51.08±10.34		
BMI	Male	150	19.49±2.88	-0.55	0.582
	Female	150	19.78±3.69		
WC	Male	150	31.13±2.32	-0.29	0.773
	Female	150	31.26±3.38		
HC	Male	150	34.91±2.74	-2.11	0.037
	Female	150	35.94±3.26		
WHR	Male	150	0.89±0.06	2.42	0.017
	Female	150	0.87±0.06		

2DR: second right digit length, 4DR: fourth right digit length, 2D:4D: digit ratio, BMI: body mass index, WC: waist circumference, HC: hip circumference, WHR: waist -to hip ratio

Table 3: Correlation between digit length, ratios and BMI

Variable	H(M)	H2	WEIGHT	BMI
2DR	0.663**	0.663**	0.291**	-0.090
4DR	0.632**	0.638**	0.229**	-0.140
2D:4DR	0.081	0.071	0.125	0.090
2DL	0.518**	0.524**	0.360**	0.070
4DL	0.471**	0.479**	0.338**	0.080
2D:4DL	0.122	0.119	0.068	-0.010

Table 4: Correlation Between Digit Ratios and WHR

Variable	WC	HC	WHR
H(M)	0.021	0.011	0.031
H2	0.012	0.006	0.026
WEIGHT	0.548**	0.671**	-0.092
BMI	0.587**	0.713**	-0.102

Table 5: Correlation Between Body Mass Index (BMI) and WHR

Variable	WC	HC	WHR
H(M)	0.021	0.011	0.031
H2	0.012	0.006	0.026
WEIGHT	0.548**	0.671**	-0.092
BMI	0.587**	0.713**	-0.102

Table 5 shows Pearson’s correlation between height, weight and BMI with waist circumference, hip circumference and waist to hip ratio. It was noted that there was no significant correlation between BMI and WHR. However, BMI shows significant positive

correlation with waist circumference and hip circumference.

Discussion

The sex-hormone profile of an individual is the main reason for the constancy of sexual dimorphism of the subsequent body parameters such as body mass index (BMI), waist-to-hip ratio (WHR) and waist-to-chest ratio (WCR). For the above reasons, low WHR in women is typically associated with high levels of circulating oestrogens, whereas high WHR is correlated with high levels of circulating testosterone (Evans *et al.*, 1983). WHR in females appears to be directly linked to health and fertility as it has been shown to be an accurate predictor of risk for various diseases (Abbott *et al.*, 2002).

The present study shows that there are significant differences between the digit lengths between male and female participants, which shows that the male has a higher value than the female for both the right and the left digits' lengths. It was also observed that the index finger was shorter than the ring finger in male. This finding agrees with the research which said that the ring finger is the fourth digit of the human hand and it is located between the middle finger and the little finger, while the index finger is the first finger, and it is second digit of the human hand. The index finger is situated between the thumb and the middle finger and is usually the most skillful and sensitive finger of the hand. The study show that males have relatively shorter index finger than the ring finger (Burriss *et al.*, 2007). The present research observes that there are no significant differences between the male and female digit ratio. However, on the left hand, there is a slight difference in which the female have higher value (0.97 ± 0.048) than the male (0.96 ± 0.098). This agrees with researches which found that the second-to-fourth digit (2D: 4D) ratio in hands is lower in males (less than 1) than in females (close to 1) (Manning *et al.*, 1998; McFadden & Shubel, 2002; Peters *et al.*, 2002). It was observed that there is significant difference between the male and the female participants in WHR with the male having a higher value than the female, which agrees with the finding that low WHR in women is typically associated with high levels of circulating oestrogens, whereas high WHR is correlated with high levels of circulating testosterone (Evans *et al.* 1983). However, the present study has shown that there are no significant correlation between both the right and the left 2D:4D with BMI. This is contrary to the finding of Fink *et al* (2003) which said that BMI was found to be positively related to digit ratio but remained significant only for the left hand 2D:4D. It was observed that there was significant negative correlation between 2D:4DL with waist to hip ratio (WHR). This agrees with research. Similarly, significant negative correlations are found between 2D:4D with WHR (Manning, 2002). However, contrary to the present study, no significant association is found for male and female digit ratio with WHR (Singh, 1995). It was noted that there is no significant correlation between BMI and WHR, but BMI shows significant positive correlation with waist circumference and hip circumference. Similarly, the present study agrees with the previous research which observed association between BMI and waist

circumference in the children. This suggests that an increase in waist circumference is not always associated with increased BMI (Pazin *et al.*, 2017). The variation in the entire results as related to previous research happens as a result of certain elements like race, age, sex, hormonal and environmentally friendly aspects disturbing the parameters, like diet, physical change and genetic factors.

Conclusion

The present study establishes the baseline data of age, digit lengths, digit ratio, body mass index (BMI) and waist -to hip ratio (WHR) of students of Yusuf Maitama Sule University Kano, Nigeria. The present study observes that there is sexual dimorphism in the between the right and left digit length, height, weight and WHR between the study participants, but there are no significant differences between all the digit ratio, waist circumference, hip circumference and BMI.

It was observed that there is no significant correlation between both the right and the left 2D: 4D with BMI. It was observed that there is significant negative correlation between 2D:4DL with waist to hip ratio (WHR). On the other hand, the 2D:4DR shows no correlation with WHR. It was noted that there is no significant correlation between BMI and WHR.

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Conflict of Interest

No conflict of interest was declared.

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Authors Contribution

Conceptualization and Data Collection: I, HIA, Data Analyses: I, MIU, Research Write up: II, HIA, MIU.

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