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Original Article

Anthropometric evaluation and significance of waist circumference, hip circumference and waist-hip ratio among 16-25 years old females in Ede, Osun State, Nigeria

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Abstract

BACKGROUND AND AIM: Anthropometry of the waist and hip, which are among the most clinically relevant include waist circumference used to assess abdominal adiposity and the waist-to-hip ratio used to assess central obesity. These parameters are of importance in the assessment of non-communicable diseases which are currently serious global health burden. The study was aimed at evaluating the waist and hip anthropometry among the female Yorubas between 16-25 years in Ede, Osun State, Nigeria and elucidating their significance.
METHODOLOGY: This cross-sectional study involved 120 undergraduate female students in Ede, Osun State, Nigeria, aged between 16 to 25 years, randomly selected to participate in the study. The waist circumference and the hip circumference were measured using the standard guidelines while the waist-to-hip ratio was calculated by dividing the waist circumference by the hip circumference. The study data was statistically analyzed using the SPSS version 22.
RESULTS: The average age of the subjects was 18.15 ± 1.35 years. The mean WC, HC and WHR for the study population were 78.90 ± 9.35, 98.55 ± 8.75 and 0.79 ± 0.05 respectively. In addition, the WC and HC showed significant increase with increasing age in the study population while the WHR showed no significant difference. The findings of this study further revealed similarity or variation when compared to other proximate and distant population.
CONCLUSION: The findings of this study provided the reference values of the study parameters among the study population which offer immense significance during various diagnostic and clinical procedures.

Keywords:
Waist circumference; hip circumference; waist-hip ratio; Yoruba tribe; Nigeria

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INTRODUCTION

Anthropometry entails the scientific study of the physical dimensions of the body or component structures of the body which include the musculoskeletal tissues, joints, viscera, vessels, integuments and others (Oludiran *et al.,* 2012; Varalakshmi *et al.,* 2017; Omotoso *et al.,* 2019; Omotoso and Ojeikere, 2024). These anthropometric derivatives have diverse applications in different medical sub-discipline and procedures such as forensic medicine, human identification, sex identification, plastic and reconstructive surgery, clinical diagnosis, and treatment planning (Omotoso and Ita-Okon, 2023; Yadav *et al.,* 2023; Ishaku *et al.,* 2024; Omotoso *et al.,* 2024).

Among the most clinically relevant anthropometric parameters in different age groups are the dimensions of the human waist and hip. The waist circumference (WC) is an important parameter used to assess abdominal adiposity and waist-to-hip ratio (WHR) is used to assess central obesity (Kulaga *et al.,* 2023). In particular, the WC is regarded as a sensitive measure of upper body fat which is useful in identification of overweight and obese young people that are risk of developing metabolic disorders (Bacopoulou *et al.,* 2015). Therefore, these parameters are of more importance due to the soaring global health concerns regarding overweight and obesity especially among the adolescent and young adult population.

Furthermore, these anthropometric parameters are vital in the prediction of cardiovascular risk factors and diseases including diabetes and hypertension in different age groups (Ali *et al.,* 2017; Amamilo *et al.,* 2020). Therefore, these parameters are of great clinical importance in the assessment of a number of non- communicable diseases (NCDs) which are currently emerging as a serious global health burden. Moreover, age- and

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gender-specific reference values in a population are used to compare with values from other population and to provide possible demarking cut-offs for obesity detection according to the International Obesity Task Force (IOTF) guidelines (Bacopoulou *et al.,* 2015).

The several important applications of these anthropometric parameters thereby necessitated the current study among the adolescent and young female adult Yorubas in Ede, Osun State, Nigeria. The study was aimed at evaluating the waist and hip anthropometry among the study population and elucidating their significance.

MATERIALS AND METHODS

Ethical Approval: The ethical approval for this study was obtained from the Research and Ethics committee of the Faculty of Basic Medical Science, Redeemer's University, Ede, Osun state Nigeria. (Reference Number: RUN/FBMSERC/ANA/2022/29). The data collection process was conducted only after obtaining the informed consent of the study participants and the study procedure was in conformity with the Helsinki declaration for study involving human subjects

Study population: This cross-sectional study was conducted among the female undergraduate students of Redeemer's University, Ede, Osun State, Nigeria. The sample size was determined by formula given by Ishaku *et al.,* (2024) as follows:

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

where: n = Minimum sample size
Z = Standard normal deviation 1.96 at 95% confidence level
p = Proportion of target population 50% (0.5)
q = 1-p = 1-0.5 = 0.5
d = Sample error 10% (0.1)

$$n = \frac{(1.96)^2 \text{ X } 0.5 \text{ X } 0.5}{(0.1)^2}$$

n = 96

Random sampling technique was used to select the study subjects which included 120 females between age of 16 to 25 years.

Inclusion and exclusion criteria: The current study involved only female undergraduate students with paternal and maternal ancestry from the Yoruba tribe in Southwest region of Nigeria. In addition, only apparently healthy female subjects without any lower limb deformity, asymmetry or injury were included in this study. Prospective subjects that failed to meet the inclusion criteria, especially those with medical history of hypertension, and diseases of gastrointestinal, and renal systems, were excluded from this study.

Collection of study data: The age of each subject was recorded prior to the anthropometric measurements by the trained personnel. The measurement of waist and hip circumferences was carried out in horizontal plane, when each subject is in a standing anatomical position, directly on the skin or while putting on very thin textured clothing, and according to the World Health Organization (WHO) guidelines. The waist circumference was measured at the junction midway between the lowest rib and the iliac crest while the hip circumference was measured at the level of maximum lateral protuberance of the hip or gluteal region (or buttocks) usually at the level of greater trochanters of the femur (Bacopoulou *et al.,* 2015).

The measurements were conducted using standard measuring tape and recorded to the nearest millimeter. Each measurement was done in duplicate with the average value evaluated and used as the final value to reduce the error margin. In addition, the waist-to-hip ratio for each subject was calculated using the following formula (WHO, 2008) and recorded:

$$\text{WHR} = \frac{\text{Waist circumference (cm)}}{\text{Hip circumference (cm)}}$$

Statistical analysis: The study data was statistically analyzed using the Statistical Package for Social Sciences (IBM-SPSS) version 22. The statistical values were expressed as mean ± standard deviation (SD), the t-test was used to compare values with $p<0.05$ set as the level of significance.

RESULTS

The average age of the study participants was 18.15 ± 1.35 years. The mean values of the WC, HC and WHR of the study population were 78.90 ± 9.35, 98.55 ± 8.75 and 0.79 ± 0.05 respectively (Tables 1). In addition, the WC and HC showed significant increase between the two age groups - 16-20 years and 21-25 years of the study population (Table 1). The findings of this study further revealed similarity or variation compared to those reported from different population (Table 2).

Table 1: The waist and hip anthropometry among the study subjects.

Age group	WC (cm)	HC (cm)	WHR
16-20 years (n = 65)	75.88 ± 8.75	93.55 ± 7.88	0.82 ± 0.03
21-25 years (n = 55)	81.97 ± 9.67*	99.78 ± 8.95*	0.83 ± 0.05
Total study population (n = 120)	78.90 ± 9.35	98.55 ± 8.75	0.79 ± 0.05

WC = waist circumference, HC = hip circumference, WHR = waist-to-hip ratio, SD = standard deviation, *** =** indicate significant difference at $p<0.05$ compared to 16-20 years age-group

Table 2: The comparison of WC, HC and WHR in different population.

References	Country (Region/Tribe)	Study population (Age)	Study subjects (sample size)	WC	HC	WHR
Jaeschke *et al.,* (2015)	Germany	Adults (20-69 years)	Male (n=27)	96.1 cm	99.8 cm	0.96
			Female (n=32)	84.3 cm	101.9 cm	0.83
Ali *et al.,* (2017)	Pakistan	Adults	Male (n=70)	39.13 ± 5.25 inch	42.74 ± 5.72 (inch)	0.95 ± 0.05
			Female (n=30)	39.27 ± 5.43 inch	41.36 ± 4.99 (inch)	0.91 ± 0.05
			Total (n=100)	39.22 ± 5.35 inch	42.28 ± 5.50 (inch)	0.93 ± 0.05
Badaruddoza and Barna (2010)	India (Sikh)	Adults (20-26 years)	n=150	71.11 ± 8.06 cm	92.82 ± 7.10 cm	0.76 ± 0.05
	India (Hindu)		n=150	70.95 ± 7.70 cm	92.73 ± 7.08 cm	0.76 ± 0.05
Singh *et al.,* 2018	India (Amristar)	Adults (18-23 years)	Male (n=120)	84.55 ± 9.00 cm	90.80 ± 8.13 cm	0.93 ± 0.01
			Female (n=98)	81.22 ± 10.36 cm	87.85 ± 11.74 cm	0.92 ± 0.01
Oktariza *et al.,* 2021	Indonesia	Adults (18-22 years)	Male (n=74)	82.1 ± 13.8 cm	97.2 ± 9.8 cm	0.80 ± 0.07
			Female (n=76)	74.6 ± 9.6 cm	96.9 ± 8.7 cm	0.84 ± 0.07
			Total (n=150)	78.3 ± 12.4 cm	97.1 ± 9.2 cm	0.77 ± 0.05
Ahmad *et al.,* 2016	Malaysia	Adults (18 years and above)	Male (n=273)	86.40 ± 12.47 cm	-	0.90 ± 0.08
			Female (n=396)	85.05 ± 13.94 cm	-	0.86 ± 0.08
			Total (n=669)	85.60 ± 13.37 cm	-	0.88 ± 0.009
Wang *et al.,* 2008	China	Adults	Males (n=59,874)	87.6 ± 9.1 cm	-	0.90 ± 0.06
			Females (n=15,914)	83.0 ± 10.3 cm	-	0.86 ± 0.08
Ahmed and Sayed 2016	Egypt	Adolescents				
		16 years	Male (n=65)	80.3 ± 12.0	98.4 ± 10.8	0.81 ± 0.05
			Females (n=82)	77.9 ± 10.0	98.8 ± 9.0	0.78 ± 0.06
		17 years	Male (n=45)	80.5 ± 11.0	99.2 ± 9.8	0.80 ± 0.04
			Females (n=47)	79.3 ± 12.7	99.5 ± 13.0	0.79 ± 0.07
Rufa'i *et al.,* 2019	Nigeria (North)	Adults (22.51 ± 2.20 years)	Female (n=364)	79.36 ± 10.04	97.15 ± 9.59	0.81 ± 0.06
Present study	Nigeria (South/Yoruba)	Adults (16-25 years)	Female (n=120)	78.90 ± 9.55	98.55 ± 8.75	0.79 ± 0.05

WC= waist circumference, HC = hip circumference, WHR= waist-to-hip ratio

DISCUSSION

The current study assessed the morphometry of the waist and hip of the adolescent and young adult female undergraduate students in Ede, Osun State, Nigeria. Generally, these parameters are essential in the assessment of the health status of an individual. The results of this study showed the mean WC, HC and WHC values of 78.90 ± 9.35, 98.55 ± 8.75 and 0.79 ± 0.05 respectively among the study population.

The studies by Rufa'i *et al.,* (2019) and Ahmed & Sayed (2016), conducted among the proximate Northern Nigerian and Egyptian population respectively, reported similar outcomes with the current study. However, the previous studies conducted among the distant Asian and European population reported significantly different results compared to the findings of the current study (Wang *et al.,* 2008; Ahmad *et al.,* 2016; Singh *et al.,* 2018). The study parameters thereby exhibited inter-population or population-based variation which is characteristic of several anthropometric parameters.

The normal WC for males usually ranges from 90 cm to 95 cm while the normal values in females ranges from 80 cm to 85 cm. In addition, the male and female WHR ranging from 0.85 – 0.90 and 0.75 – 0.80 respectively are categorized as healthy groups while the males and females with WHR above 0.95 and 0.85 respectively are at risk of diseases associated with obesity (Bray *et al.,* 1998; Ravishankar *et al.,* 2018). Based on the findings of the current study, majority of the study population apparently belong to the healthy group.

The WC is commonly used to assess abdominal adiposity which in turn play major role in the detection of changes in the lipid and carbohydrate metabolism and associated clinical correlates (Singh *et al.,* 2024). The WHC, which combines WC and HC, presents a more precise indicator of abdominal fat accumulation which is useful in health risks associated with central obesity including cardiovascular disease (like coronary heart disease) and diabetes mellitus (Ravishankar *et al.,* 2018; Singh *et al.,* 2024).

Essentially, the WC and HC are essentially the determinants of the WHR such that larger WC indicate increased WHR thereby indicating greater central obesity and vice versa while the HC exerts inverse influence on the WHR (Singh *et al.,* 2024). In a growing population (including the current study), the WHR could be influenced by various factors such as abdominal contents (fat and non-fat), abdominal muscle tone, posture, spinal curvature, hip bony and muscular dimensions (Amamilo *et al.,* 2020). Other factors that could impact the abdominal adiposity indicators

include income level, educational level, unhealthy habits such as smoking and drinking (Qian *et al.,* 2019).

Furthermore, studies have demonstrated the correlation of abdominal obesity with the risk of chronic diseases with high WHR reported as veritable predictor of clinical conditions such as dyslipidemia, diabetes and hypertension (Veghari *et al.,* 2018; Shrestha *et al.,* 2021). Other clinical conditions where obesity has been implicated include insulin resistance, sleep apnoea, osteoarthritis, gout, hyperuricaemia, polycystic ovarian syndrome, psychological disorders and many more (Kularathne *et al.,* 2019; Ozdemir, 2023). The study by Kamel *et al.,* (2017) further highlighted the role of WC and WHR in assessing rheumatoid arthritis (RA) with their findings indicating that the WHR was better associated with the disease activity, disability, and severity of the disease than other parameters.

The WC alone or in combination with BMI has demonstrated better prediction of hypertension than BMI alone. The study by wang *et al.,* (2008) further demonstrated the usefulness of WC and BMI for the prediction of two or more non-adipose components of metabolic syndrome. In addition, high WHR has been reported in individuals with high fasting blood glucose (FBG) whereby free fatty acid inflow into the liver often leads to increased abdominal adiposity (Oktariza *et al.,* 2021). In essence, the higher WHR values that characterized abdominal adiposity are associated with unhealthy lifestyle factors including lack of regular physical activity and unhealthy diets (Singh *et al.,* 2024).

Conclusion: The findings of the current study provided the reference values of the anthropometric parameters among the study population. These values offer immense significance during the aforementioned diagnostic and clinical procedures that involve the study population. Furthermore, the waist and hip anthropometry should be routinely assessed both on individual and clinical settings in order to monitor the health status of the study population.

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