

# IDENTIFICATION OF THE ANTHROPOMETRIC INDEX THAT BEST CORRELATES WITH FASTING BLOOD GLUCOSE AND BMI IN POST-PUBESCENT FEMALE NIGERIANS

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## ABSTRACT

The association between anthropometric indices and the incidence of metabolic disturbances varies between age groups and races. In this study, we report the relationship between fasting blood glucose (FBG) and some anthropometric markers of body mass and central obesity in a population of post-pubescent female Nigerians (16-23 years). After obtaining written consent from each of the 178 subjects; and the completion of a questionnaire on individual demographics, we collected the following anthropometric data: waist circumference (WC), hip circumference (HC), height (H), and weight (W). We also estimated the body mass index (BMI), waist to hip ratio (WHR), and waist to height ratio (WHtR). Fasting blood glucose (FBG) was estimated using a glucometer. The mean FBG was 83.65 mg/dl and this was best positively and significantly correlated with BMI ( $r=0.15$ ;  $P<0.05$ ) in this population. Besides, among other obesity markers, WHtR was most strongly and significantly correlated with BMI ( $r=0.70$ ;  $P<0.05$ ). Our data shows that in young (post-pubescent) female Nigerians, the best anthropometric indicator of FBG (and thus of metabolic status), is the BMI, and this is most strongly correlated with WHtR in this particular population.

**Key words:** Fasting blood glucose; Anthropometric index; Post-pubescent Nigerians; BMI; WHR; WHtR.

## INTRODUCTION

Collection of anthropometric data from healthy subjects and patients has become a valid means of scientific and clinical investigations. The traditional body mass index (BMI) is still clinically relevant in the 21<sup>st</sup> century as an essential anthropometric index. Several studies have associated increased cardiovascular and metabolic risks with increasing BMI (Sung et al., 2007; Ghazali and Sanusi, 2010).

Moreover, other anthropometric indices have found relevance in scientific and clinical settings. Across age groups, significant association has been documented between waist circumference (WC) and cardiometabolic

risk factors (including obesity, hypertension, dyslipidaemia, and impaired fasting blood glucose). Studies have shown that WC and waist to hip ratio (WHR) correlate positively with central obesity and metabolic risks (Schmidt et al., 1992; Dalton et al., 2003; Norberg et al., 2006; Dube et al., 2010; Ghazali and Sanusi, 2010). As a result, the World Health Organization (WHO) has given significant consideration to these obesity markers in its effort to check cardiometabolic diseases (WHO, 2008).

A recent systematic review suggests that waist to height ratio (WHtR) and WC are superior to

BMI as predictors of metabolic risk (Browning et al., 2010). A study of WHtR in a Nigerian geriatric (elderly) population showed that this anthropometric index predicts metabolic syndrome better than BMI (Chukwunonso, 2011). Moreover, recent studies in Asian populations aged 40 to 60 years reported strong correlations between WC and FBG (Hardiman et al., 2009).

However, it is unclear which anthropometric index (among WC, HC, WHR, WHtR, and BMI) has the strongest association with FBG in a post-pubescent female Nigerian population. In the present study therefore, we report the relationship between fasting blood sugar and some anthropometric indices in non-obese post-pubescent female Nigerians.

## SUBJECTS AND METHODS

The study population comprised female undergraduate students attending the University of Ilorin, Nigeria. A total of 178 female subjects (16-23 years old) participated in the study after obtaining written informed consent from them. The study was conducted between 2011 and 2012 in Ilorin, North-central Nigeria. Each participant completed a questionnaire that requests information on health status of the individual (e.g., cases of diabetes and related conditions), medication, and demographics. The Research Ethics Committee of the University of Ilorin approved the study protocol.

For each participant, FBG was taken in the morning between 07:00 and 10:00 hours; using a hand-held glucometer (One Touch glucometer, Lifescan, USA). Anthropometric parameters taken in duplicate from each subject included body weight, standing height, hip circumference, and waist circumference. Standing height was taken in the Frankfurt position with the aid of a stadiometer; while body weight was recorded using a Hana mechanical personal scale (China). Waist

circumference was measured with a tape placed at a point mid-way between the costal margin and the iliac crest. Hip circumference was taken using a tape placed at the level of the greater trochanter of the femur. From the data obtained, the following calculations were made:

Body mass index (BMI) = weight (kg)/ height<sup>2</sup> (m<sup>2</sup>)

Waist to hip ratio = waist circumference (cm)/hip circumference (cm)

Waist to height ratio = waist circumference (cm)/height (cm)

### Statistics

FBG and anthropometric data are reported as mean  $\pm$  standard deviation (mean  $\pm$  SD). Correlations between the anthropometric parameters and FBG were estimated by the Pearson's correlation coefficient method, using the SPSS version 20.  $P < 0.05$  was considered significant.

## RESULTS

### FBG and anthropometric parameters of post-pubescent female Nigerians

All the enlisted female subjects for this study were euglycaemic, with FBG of  $83.65 \pm 9.70$  mg/dl. The subjects were neither overweight

nor obese, (BMI =  $21.40 \pm 3.38$  kg/m<sup>2</sup>), and most other anthropometric parameters were within the normal ranges (Table 1).

### FBG is best correlated with BMI in post-pubescent young female Nigerians

In contrast to other anthropometric parameters evaluated, FBG best positively correlates with BMI ( $r = 0.15$ ;  $P < 0.05$ ) in post-pubescent female Nigerians (Table 2). A positive correlation of 0.12 also exists between FBG and WHR ( $P > 0.05$ ), and a correlation of 0.10 exists between FBG and WHtR ( $P > 0.05$ ) (Table 2).

### **BMI and WHtR are strongly correlated in post-pubescent female Nigerians**

Among the anthropometric parameters studied in post-pubescent female Nigerians, BMI has the strongest positive correlation of 0.70 with WHtR ( $P < 0.05$ ). The relationship between BMI and WHR was however weak in this population ( $r = 0.14$ ;  $P > 0.05$ ) (Table 3).

**Table 1.** FBG and some anthropometric indices in young adult female Nigerians.

Variable measured	Population size (n)	Mean $\pm$ SD
<b>FBG (mg/dl)</b>	178	83.65 $\pm$ 9.70
<b>HC (cm)</b>	178	92.72 $\pm$ 7.89
<b>WC (cm)</b>	178	70.48 $\pm$ 7.35
<b>Height (m)</b>	178	1.62 $\pm$ 0.06
<b>Weight (kg)</b>	178	56.05 $\pm$ 8.53
<b>WHR</b>	178	0.76 $\pm$ 0.04
<b>WHtR</b>	178	0.43 $\pm$ 0.05
<b>BMI (kg/m<sup>2</sup>)</b>	178	21.40 $\pm$ 3.38

Mean  $\pm$  SD: mean  $\pm$  standard deviation

**Table 2.** Pearson's correlation coefficient between FBG and some anthropometric indices in post-pubescent female Nigerians.

	<b>FBG</b>
<b>HC</b>	0.063
<b>WC</b>	0.056
<b>WHR</b>	0.120
<b>WHtR</b>	0.100
<b>BMI</b>	0.150 <sup>a</sup>

a =  $P < 0.05$

**Table 3.** Pearson's correlation coefficient between BMI and some anthropometric indices in post-pubescent female Nigerians.

	<b>BMI</b>
<b>HC</b>	0.67 <sup>a</sup>
<b>WC</b>	0.63 <sup>a</sup>
<b>WHR</b>	0.14
<b>WHtR</b>	0.70 <sup>a</sup>

a =  $P < 0.05$

## DISCUSSION

The present anthropometric study aims to identify the anthropometric index that best correlates with FBG in post-pubescent Nigerian females. In this population, all anthropometric indices evaluated, as well as the FBG, were within the normal ranges (Table 1).

Our findings show that in healthy post-pubescent female Nigerians (16-23 years), FBG best positively and significantly correlates with BMI ( $r=0.15$ ;  $P<0.05$ ). This shows that relative to other indices of body mass and obesity (WC, HC, WHR, and WHtR), BMI best predicts FBG in this young female Nigerian population.

In contrast, in a recent study by Chukwunonso (2011) in a Nigerian male geriatric population (65-84 years), WHtR best associates positively and significantly with metabolic syndrome. This suggests that while WHtR could be the best anthropometric indicator of FBG and metabolic syndrome in older male Nigerian population (Chukwunonso, 2011), BMI best serves the same purpose in younger female Nigerians, as reported in our study. Moreover, when compared with studies in Zimbabwe, BMI is reportedly the best predictor of T2D and metabolic syndrome in the Bulawayo district of Zimbabwe in a population aged 20-70 years (Dube et al., 2010). Our data also agrees with a study among Swedish population, where BMI best predicts fasting blood glucose and type 2 diabetes (T2D) (Norberg et al., 2006).

In contrast, in different Asian populations, WC and WHR positively correlate with and are best predictors of FBG and T2D (Gupta et al., 2007; Sandhu et al., 2008; Shah et al., 2009). This is also similar to findings in adult Australians and Americans where WHR is the strongest anthropometric indicator in identifying cardiovascular risk factors in these populations (Schmidt et al., 1992; Dalton et al., 2003).

Meanwhile, it is presently unclear which factors account for the strong correlation between BMI and FBG on one hand in certain populations

(e.g., present study); and WHR (or WHtR) and FBG on the other hand in some other populations (Shah et al., 2009; Dalton et al., 2003). Nevertheless, age and/or sex difference between the various study populations, genetic and race differences (Wei et al., 1997); and epigenetic or environmental factors, may contribute. Other population-specific factors such as differences in diet and lifestyle, preponderance of general obesity (indicated by BMI) as opposed to central obesity (indicated by WHR or WHtR), may also be responsible.

Whichever factors do account for our findings in the present studies, the stronger correlation between BMI and FBG in young post-pubescent female Nigerians (16-23 years) suggests that generalized obesity has greater influence on FBG in this population, as opposed to central obesity reported for the male geriatric population (65-84 years) (Chukwunonso, 2011).

Moreover, it is obvious from the foregoing that most anthropometric studies that relate markers of obesity with FBG/incidence of T2D have been done in older adult populations (Schmidt et al., 1992; Dalton et al., 2003; Norberg et al., 2006; Dube et al., 2010). Our study is thus one of the relatively few anthropometric work that considers the correlation between the indices of body mass and FBG in the post-pubescent female population (16-23 years). We have shown that BMI has the strongest positive and significant correlation with FBG in this group (Table 2).

Furthermore, we also studied which anthropometric index (among WC, HC, WHR and WHtR) shows the strongest correlation with BMI in young post-pubescent female Nigerians. Our data shows that WHtR is positively and most strongly correlated with BMI ( $r=0.7$ ;  $P<0.05$ ) (Table 3). However, in this population, the positive association between FBG and WHtR ( $r=0.10$ ) is not significant ( $P>0.05$ ), and is weaker than the significant relationship between FBG and BMI ( $r=0.15$ ;  $P<0.05$ ).

We have therefore shown in the present study that the best anthropometric predictor of FBG and thus, metabolic status, in post-pubescent (young) female Nigerians is the BMI, and this anthropometric index is positively and

significantly associated with WHtR in this particular population.

**Conflict of interest:** We declare no conflict of interest.

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