ORIGINAL ARTICLE

ANTHROPOMETRIC CORRELATES OF INSULIN RESISTANCE: A STUDY OF HEALTHY NIGERIAN ADULTS IN MAIDUGURI

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ABSTRACT

Background: Indices of obesity, especially abdominal adiposity have been shown to correlate positively with the components of the metabolic syndrome in several studies.

Objectives: The aim of this study was to determine the correlation between anthropometric indices and insulin resistance in healthy subjects.

Methods: A representative sample of 100 subjects aged 15 to 70 years was recruited for the study. Weight, height, waist circumference (WC) and hip circumference were measured, while body mass index (BMI) and waist-to-hip ratio (WHR) were calculated for each participant. Fasting blood samples were drawn for plasma glucose and plasma insulin concentrations, respectively. The values obtained were used to calculate insulin resistance using the Homeostasis Model Assessment Method for Insulin Resistance (HOMA-IR).

Results: Insulin resistance (IR) was found in 25(25%) of the study subjects. There were significant and positive correlations between waist circumference and HOMA-IR ($r=+0.20$, $p<0.05$), as well as between BMI and HOMA-IR($r=+0.19$, $p<0.05$).Both anthropometric indices however, only predicted 4.1% and 3.9% of the variation in HOMA-IR, respectively. The correlation between WHR and HOMA-IR was positive but non-significant ($r=+0.12$, $p>0.05$).

Conclusion: Waist circumference exhibited the strongest correlation with HOMA-IR, closely followed by BMI and WHR. We recommend that measurement of waist circumference should continue to be used as a screening tool for identifying individuals with insulin resistance in our setting.

Keywords: Anthropometric indices, body mass index, waist-to-hip ratio, waist circumference, homeostasis model assessment for insulin resistance.

INTRODUCTION

Insulin resistance is defined as a diminished response of a target cell or organ to a physiological concentration of insulin. Resistance to the action of insulin is a central feature of the metabolic syndrome - a clustering of cardiovascular disease risk factors occurring commonly in the setting of obesity (particularly central adiposity).[1] The recognition of obesity is therefore paramount to the diagnosis of insulin resistance. Various anthropometric indices are used to detect obesity in metabolic syndrome (MS). For example, the National Cholesterol Education Programme (NCEP) Adult Treatment Panel III (ATP-III) [2] recommends the use of waist circumference, while the World Health Organization (WHO) recommends both body mass index (BMI) (defined as cut-offs ≥ $30kg/m^2$) and waist-to-hip ratio in the diagnosis of MS.[3]

The reason behind the measurement of these anthropometric indices is to predict the process of atherosclerosis or insulin resistance,[4] and they provides cost-effective data for comparison with the normal, and also remains "readily available" and "in-hand" reliable screening tool for the general population.[5]

Insulin resistance can be assessed by several methods, all of which estimate the relationship between plasma glucose and plasma insulin. These include the euglycaemic hyperinsulinaemic clamp technique, Quantitative Insulin-Sensitivity Check Index (QUICKI), Homeostasis Model Assessment for Insulin resistance (HOMA-IR) and insulin suppression tests.[6] With the exception of HOMA-IR; these methods are invasive, time consuming and are not suitable for community based surveys. There is paucity of data on the relationship between anthropometric indices and insulin resistance among healthy subjects in our setting.

The aim of this study was therefore, to determine the correlation between the various anthropometric indices and insulin resistance.

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Table 1: Biochemical indices and anthropometric characteristics of 73 males and 27 females selected for insulin resistance by HOMA-IR.

Variable	Males n=73	Females n=27	All subjects n=100	p value*
FPG (mmol/L)	5.3(1.9)	5.6(2.1)	4.9(1.5)	0.49
FPI (µiu/ml)	4.8(1.5)	4.9(1.2)	4.8(1.4)	0.75
HOMA-IR	1.04(0.35)	1.09(0.51)	1.05(0.41)	0.59
WC (cm)	84.1(12.4)	88.4(15.7)	83.2(13.6)	0.15
BMI (kg/m^2)	24.6(4.9)	25.2(5.3)	24.6(5.7)	0.57

Legend: * = Significance of difference between the genders. Data expressed as mean (SD).

MATERIALS AND METHODS

In this cross-sectional study, 100 subjects aged 15 to 70 years were selected out of 242 participants during a survey to determine the prevalence of obesity and overweight in Maiduguri metropolis conducted between July 2008 and January 2009. Known diabetics, subjects with physical or psychological stress and those with chronic disorders were excluded from the study.

The selected subjects were asked to report to a convenient venue for sampling in the fasting state, after brief explanation of the necessary requirements for medical fasting. On the day of reporting, the participants were subjected to detailed history, physical examination and collection of blood samples for plasma glucose and insulin. The study was approved by the ethics committee of the University of Maiduguri Teaching Hospital.

Measurement of anthropometric indices

Weight in kilogram was measured to the nearest 0.5kg with subjects clad in minimum clothing and without shoes, using a calibrated bathroom scale (Soehnle-Waagen GmbH & Co. KG, Wilhelm-Soehnle-Straße 2, D-71540 Murrhardt/Germany) positioned on a firm horizontal surface. Height in metres was measured to the nearest 0.1cm using portable locally manufactured stadiometers with subjects barefooted and without the gaze horizontal. Body mass index was calculated as weight in kilogram divided by the square of the height in metres(m^2).Waist circumference (in centimeters) was measured to the nearest 0.1cm at a point mid-way between the margin of the lowest rib and the iliac crest, while hip circumference was measured to the nearest 0.1cm at the level of the greater trochanters. Waist-to-hip ratio was calculated as the waist circumference in centimeter (cm) divided by the hip circumference in centimeter (cm).

Determination of insulin resistance

Insulin resistance was determined using the Homeostasis Model Assessment for Insulin Resistance method (HOMA-IR).This involved measurement of fasting plasma insulin and glucose. Plasma glucose was analyzed using the glucose oxidase method of Trinder [7], while plasma insulin was measured using a commercially available human insulin ELISA kit (Calbiotech, Inc. (CBI), Spring Valley, CA, USA). The values obtained were used to calculate HOMA-IR using the formula proposed by Mathew *et al* [8]:

$$\text{HOMA IR} = \frac{\text{Fasting serum insulin x Fasting plasma glucose}}{22.5}$$

Subjects with HOMA-IR values ≥ 75th percentile value were deemed to have insulin resistance in this study.

Table 2. Demographic and anthropometric characteristics of subjects with and without insulin resistance.

Variable	IR present n=25	IR absent n=75	p value
Age (years)	43.0(12.9)	40.4(13.7)	0.50
WC (cm)	97.6(18.3)	96.8(12.0)	0.57
BMI (kg/m^2)	28.0(7.9)	27.4(5.5)	0.68
WHR	0.98(0.15)	0.94(0.07)	0.07

IR – Insulin resistance

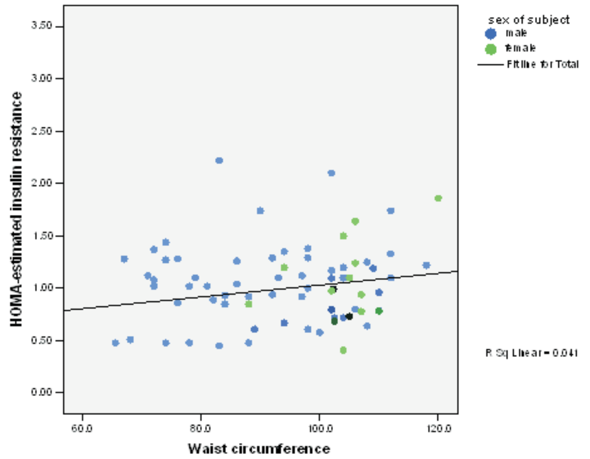

Figure 1: Scatter plot showing the relationship between Homeostasis Model Assessment for Insulin Resistance (HOMA-IR) and Waist Circumference in the insulin resistance study group.

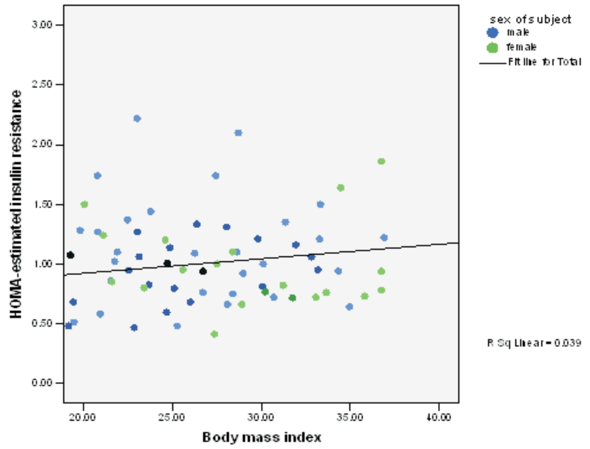

Figure 2: Scatter plot showing the relationship between Homeostasis Model Assessment for Insulin Resistance (HOMA-IR) and Body Mass Index (BMI) in the insulin resistance study group.

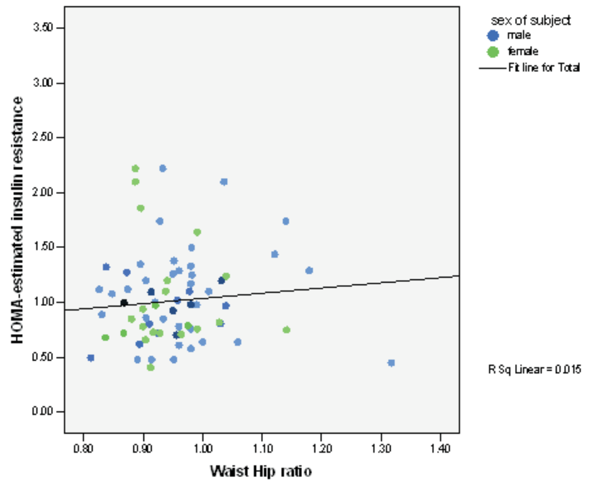

Figure 3: Scatter plot showing the relationship between Homeostasis Model Assessment for Insulin Resistance (HOMA-IR) and Waist to Hip Ratio (WHR) in the insulin resistance study group.

Statistical analysis

All data were entered into and analyzed using SPSS version 13 (SPSS, Chicago, Illinois, USA) statistical package. The mean values of the anthropometric indices and HOMA-IR were compared among the sexes using two-tailed student t-test. Pearson's correlation was used for the different anthropometric indices and insulin resistance. Keeping various anthropometric indices as dependent variable, linear regression equation was calculated to estimate the slope (B) in order to know the amount of change in dependent variable with per unit change in insulin resistance. A p-value of <0.05 was considered statistically significant.

RESULTS

Of the 100 subjects selected for the study, 73 were males while 27 were females. The mean (SD) age of the study subjects was 39.3(14.2).Table 1 shows the biochemical and anthropometric indices of the study subjects according to gender. The mean (SD) HOMA-IR of the study subjects was 1.05(0.41).Males had a mean HOMA-IR of 1.04(0.37), while for the females the mean HOMA-IR was 1.09(0.51), $p>0.05$. Insulin resistance was found in 25(25%) of the study subjects (18 males and 7 females).The mean values of age (years), BMI (kg/m^2), WC (cm) and WHR were higher in subjects with insulin resistance compared to those without it. Table 2 shows the demographic and anthropometric characteristics of subjects comparing those with and without insulin resistance. All the values were higher in subjects with insulin resistance, though the differences were not statistically significant.

There was a positive and significant correlation between HOMA-IR and waist circumference ($r=0.20$, $p<0.05$), as shown in Figure 1. Waist circumference in this study however, explained only 4.1% of the variation in HOMA-IR. The latter can be predicted from the WC using the regression equation: HOMA-IR= -3.5 + 0.075WC. Figure 2 shows that the correlation between HOMA-IR and BMI($r=0.19$, $p<0.05$) was also significant. The BMI contributed 3.9% to the variation in HOMA-IR, which can be predicted from the regression equation: -3.0 + 0.15BMI. Figure 3 shows the relationship between HOMA-IR and WHR. The relationship was positive but non-significant($r=0.12$, $p>0.05$). The WHR explained only 1.5% of the variation in HOMA-IR. Again, the HOMA-IR can be predicted from the regression equation: HOMA-IR = -4.5 + 5.83WHR. Overall, WC had the strongest correlation with HOMA-IR compared to all the other anthropometric indices tested. It also explained the greatest variation in HOMA-IR.

DISCUSSION

To the best of our knowledge, this is the first study on the correlation between anthropometric indices and insulin resistance among healthy subjects in our setting. In this study, we used the Homeostasis Model Assessment of insulin resistance method to identify individuals with insulin resistance. This method was used because it is simple, requiring only measurement of plasma insulin and plasma glucose and appropriate to developing countries. The mean HOMA-IR of 1.05(0.4) found in this study, is similar to the value reported by Bakari *et al* [9] in non-diabetic subjects, but higher than the mean HOMA-IR in Cameroonians as reported by Fezeu *et al* [10] The reason for the higher value in this study compared to the figures from Cameroon, may be that our subjects were older [39.3(14.2) years vs. 37.5(9.0) years]. Insulin resistance has been shown to be relatively higher in older individuals than in the young.[11]

Twenty-five (25%) of our study subjects demonstrated a HOMA-IR of ≥ 1.24 i.e. were insulin resistant. This figure is higher than the 19.4% reported by Bakari *et al* [9] among their subjects. The higher HOMA-IR cut-off used for defining insulin resistance in the latter study may account for the observed difference. Our study revealed a positive and significant correlation between HOMA-IR and waist circumference. This marker of central obesity however, only explained 4.1% of the variation in HOMA-IR. This suggests that central obesity in our subjects was not strongly associated with HOMA-IR. Fezeu *et al* [10] in a study of the prevalence of metabolic syndrome in rural and urban Cameroonians also reported that WC correlated better with other metabolic syndrome (MS) components than with HOMA-IR.

The BMI also correlated well with HOMA-IR, though contributed only 3.9% to the variation in HOMA-IR. Ethnicity may explain this observation. In addition, studies have shown that blacks tend to have lower body fat for the same BMI than Caucasians.[12] This has implications on the interrelationship between obesity (as defined by BMI) and the other components of the metabolic syndrome. Of the anthropometric indices tested, WHR had the weakest correlation with HOMA-IR($r=0.12$, $p>0.05$). It also explained only 1.5% of the variation in HOMA-IR. Although WHR measures central fat deposition, it is a poor measure of visceral fat mass, particularly in lean individuals.[10] Given the established association between excess accumulation of visceral adipose tissue(which can be found even in non-obese individuals) and insulin resistance, WHR would be expected to correlate poorly with insulin resistance compared to WC as demonstrated in this study. On the contrary, other studies have shown WHR to be a better marker of insulin resistance than WC. [13,14]

Waist circumference in this study, exhibited the strongest correlation with HOMA-IR (a measure of insulin resistance) closely followed by BMI and WHR. The latter had the weakest correlation with HOMA-IR. Based on our findings, we recommend that measurement of waist circumference should continue to be used as a screening tool for identifying individuals with insulin resistance in our setting.

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