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Full Length Research Paper

Association of atherogenic indices and abdominal obesity indices among non obese adults in Zaria, Northern Nigeria

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Prior epidemiological studies and comparative analyses of correlations between abdominal obesity and dyslipidemia have been limited to obese participants but few data are available for the non obese adults of this study population. This study examined the associations between atherogenic and obesity indices among non obese adults of Samaru, a suburb of Zaria in Kaduna state, Nigeria. The study protocol was duly approved by the Ethical committee of Ahmadu Bello University Teaching Hospital, Shika, Zaria. This cross sectional study examined a total of 174 non obese adults, 35 to 70 years of age (male, 91; female, 83) who were randomly selected for the study. All subjects were normotensive and not on any lipid lowering medications. Normal-weight body mass index (BMI) of 18.5 to 24.9 kg/m^2 and overweight BMI ≤ 27 kg/m^2 was considered in the study. Descriptive statistics and Partial correlation were used to determine the relationship between atherogenic and obesity indices, after controlling for age. Results showed significant ($p \leq 0.05$) relationships between Log (TG/HDL) and waist-hip ratio (0.0001*) as well as waist-height ratio (0.003*), waist circumference (0.013*) and body mass index (BMI) (0.041*) in males but not in females. Waist-hip ratio was the most important and consistent index of adiposity that associated with the atherogenic index [Log (TG/HDL)] in male and no relationship was shown in female non obese adult group. This could be an indication that the distribution of fat deposits in non- obese men may be a better predictor of cardiovascular diseases, metabolic abnormalities and frequent macrovascular complications than the degree of obesity alone and might be at higher risk than women. The strong correlations of Log (TG/HDL) with abdominal fatness compared to other atherogenic indices that is, (TC/HDL and LDL/HDL) in this study has confirmed the statistical reliability of Log (TG/HDL) as a tool in the assessment of cardiovascular risk factors among non- obese adults.

Key words: Non-obese adults, atherogenic index, waist-hip ratio, Zaria.

INTRODUCTION

The constellation of metabolic abnormalities or metabolic syndrome (MetS) that are characteristically associated with adult onset obesity have been widely investigated (Song et al., 2006; Opie, 2007; Zhao et al., 2010). It has

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also been reported that there are individuals who by standard weight/BMI tables are not obese or even overweight, but have metabolic abnormalities that are characteristically associated with adult onset obesity (St-Onge et al., 2004; Tsai, 2009).

Abdominal obesity has been implicated in several studies of non obese adults as best surrogate of risk factors accumulation, cardiovascular disease and death, independent of commonly used indices of obesity example, waist circumference (WC), BMI, waist-hip ratio (WHpR) and waist-height ratio (WHtR) (Baba et al., 2010; Dhall et al., 2011). Many attempts in the evaluation of cardiovarscular disease risks in asymptomatic individuals remain suboptimal and there is also controversy around recommending widespread use of metabolic markers. Some established markers of cardiovascular disease risks have been identified such as cholesterol esterification rate in apolipoprotein, plasminogen activator inhibitor-1, atherogenic index and C-reactive protein levels, but their independent contributions to risk factor accumulation remains a matter of debate (Van Gaal et al., 1988; Khazaal, 2013)

The atherogenic index (AI) is an emerging index that is fulfilling the criteria to be used as a stand-alone index for cardiac risk stratification (Khazaal et al., 2013). Lipid profile and atherogenic index have been shown to be significant predictors for metabolic abnormalities including dyslipidemia, atherosclerosis, hypertension and cardiovascular diseases. Changes in the levels of lipids make the individuals more inclined to develop these atherosclerotic cardiovascular diseases and endothelial dysfunction (Shah et al., 2010; Kanthe et al., 2012). This study population is limited to non obese adults because the proportionate risk of cardiovascular diseases among non obese adults has not gotten enough attention. The aim of the present study was to examine the association of lipid profile, atherogenic index and obesity indices among non obese adults in an attempt to lay out health risk factors among non obese adults.

MATERIALS AND METHODS

A cross-sectional survey was conducted on non obese adults, aged 47.13 ± 8.10 years (male) and 44.96 ± 9.58 years (female) in March, 2013. Study participants were randomly selected from different wards in Samaru, a suburb of Zaria in Kaduna state, Northern Nigeria. The Samaru town is the fourth and the most recent addition to the Zaria suburban area. It evolves from a small colonial farming settlement to become a large community, a melting-pot, often referred to as 'the University village'. It is cosmopolitan in nature, drawing and fusing people of diverse national and international backgrounds. Data from 174 non obese adults (male, 9; female, 83) were collected. Exclusion criteria were: obese, untreated cases of hypertension or diabetes, triglyceride (TG) greater than 4.50 mmol/l, taking lipid lowering medications or failure to fast prior to tests. All candidates enrolled in this study underwent a physical examination to obtain anthropometric measures. Body weight was measured with light clothes and without shoes, and was approximated to the nearest 0.1 kg on a mobile lever scale (SECA; Vogel and Halke; Germany) and height was measured to the nearest 0.1 cm using a stadiometer (SECA; Vogel and Halke; Germany). Waist circumference (WC) was measured by a non-elastic flexible tape in the standing position. The tape was applied horizontally midway between the lowest rib margin and the iliac crest. Hip circumference (HC) was measured at maximal protrusion of the buttocks. The mean of two measurements to the nearest 0.1 cm were documented.

Normal-weight BMI was defined as a range of 18.5 - 24.9 kg/m^2 according to National Institutes of Health (NIH)/ National Heart, Lung, and Blood Institute (NHLBI) 1998 criteria and overweight BMI ≤ 27 kg/m^2 was considered because BMI ≥ 28 kg/m^2 has been shown to be a significant prognostic factor for all-cause and cardiovascular mortality among adults (Asefeh et al., 2001; Ofei, 2005).

Waist-height ratio was calculated as: waist circumference /height.
Waist-hip ratio was calculated as: waist circumference/hip circumference.
Body mass index was calculated as: weight/height (kg/m^2)

For lipid profile study, 3 ml of blood was collected from each subject after overnight fasting of 12 h. Serum values of TC, HDL, and TG were measured using a spectrophotometer: (Infinity^{TM}, TECO diagnostics U.S.A.). The value for low density lipoprotein (LDL) was calculated using the Friedewald´s formula:

LDL = TC-HDL-(TG/2.17) mmol/l.

Atherogenic index was calculated using formula:

Log (TG/HDL-C), TC/HDL and LDL/HDL (Goh et al., 2004).

The presence of dyslipidemia was considered according to international diabetic foundation (IDF) (2005) recommendations. The study purpose was explained to all volunteers before seeking their written consent. Ethical clearance was obtained from the ethical committee of Ahmadu Bello University Teaching Hospital, Shika Zaria.

Statistical analysis

Data was analyzed using statistical package for social sciences (SPSS Inc, version 16. 0; Chicago). Descriptive statistics of mean and standard deviation was computed for the purpose of data interpretation. Partial correlation analysis was used to examine the relationship between obesity indices and lipid profile after controlling for age. Correlations were considered significant at P≤0.05 with critical values located at 0.2050 (male) and 0.2172 (female).

RESULTS

Descriptive characteristics of the study population as presented in Table I, consists of (91) male and (83) female with mean BMI of 23.13 kg/m^2 ± 2.73 (male) and 23.78 kg/m^2 ± 2.42 (female). Statistical equality of means at P≤0.05 showed that male participants were significantly taller and heavier with smaller hip circumference than the female. No significant differences existed in the lipid profile and age between male and female participants (P≤0.05). The mean values of waist height ratio (WHtR) (male: 0.508 ± 0.048; female: 0.535 ± 0.05) and waist hip ratio (WHpR) (male: 0.941 ± 0.05; female: 0.876

Table 1. Characteristics of the study participants.

Measurement	Male (n=91) Mean ±SD	Female (n=83) Mean ±SD
Age (years)	47.13±8.10	44.96±9.58
Weight (kg)*	69.55±9.60	62.90±7.96
Height (cm)*	173.32±6.42	162.58±6.09
Waist circumference (cm)	87.90± 8.17	86.87 ±7.70
Hip circumference (cm)*	93.37±6.12	99.27±6.48
Body mass index (kg/m^2)	23.13±2.73	23.78 ±2.42
Waist-hip ratio*	0.941±0.050	0.876 ±0.06
Waist-height ratio*	0.508±0.048	0.535 ±0.05
Total cholesterol (mmol/dl)	3.13±1.12	3.017±0.83
Triglyceride (mmol/dl)	1.37±1.11	1.150 ±0.82
High density Lipoprotein (mmol/dl)	0.944±0.325	0.955 ±0.37
Low density lipoprotein (mmol/dl)	1.63 ±0.904	1.581±0.71
Log (Tg/HDL)	0.106±0.26	0.052±0.28
LDL/HDL	1.787±0.92	2.055±1.97
TC/HDL	3.421±1.02	2.055±1.97

*Statistical significant difference of equality of means at (CI 95%, P ≤ .05; Critical value: 1.960; Df: 172).

Table 2. Correlation between measures of adiposity and lipid profile.

Parameter	Male				Female			
	WC	BMI	WHpR	WHtR	WC	BMI	WHpR	WHtR
TG	0.013*	0.041*	0.001**	0.003*	0.637	0.827	0.050*	0.436
TC	0.003*	0.029*	0.717	0.044*	0.809	0.533	0.533	0.935
HDL	0.154	0.337	0.580	0.161	0.558	0.814	0.952	0.728
LDL	0.012*	0.062	0.808	0.151	0.675	0.918	0.514	0.998
Log (TG/HDL)	0.016*	0.040*	0.001**	0.008*	0.924	0.728	0.270	0.524
LDL/HDL	0.088	0.239	0.803	0.660	0.854	0.280	0.841	0.802
TC/HDL	0.063	0.186	0.857	0.525	0.985	0.415	0.868	0.889

**Correlation is significant at the 0.01 level (2-tailed) *Correlation is significant at the 0.05 level (2-tailed) Critical value: 0.2050. P: ≤0.05

± 0.06) were slightly above the classified risk values of Kuba et al. (2013). Table 2 showed correlations between adiposity indices and the lipid profile in male and female. Significant positive relationships between the indices of adiposity and Log (TG/HDL) was noticed in males but not in females (WC, 0.016*, BMI, 0.040*, WHpR, 0.001** and WHtR, 0.008*), with WHpR showing the best correlation. Other indices of atherogenicity (TC/HDL and LDL/HDL) did not show any relationship with adiposity indices in both sexes. TG also showed a similar trend of significant relationships with indices of adiposity in male (WC, 0.013*, BMI, 0.041*, WHpR, 0.001** and WHtR, 0.003*) and only with WHpR (0.050*) in female. HDL showed no relationship with any of the adiposity indices in both sexes. WC is the only adiposity index in male that showed a multivariate relationship with TG (0.013*), TC (0.003*), LDL (0.012*) and Log (TG/HDL) (0.016*) but not in females. Figure 1 represent the clinical implication of WHpR in male as it shows strong relationship with Log (TG/HDL) (R^2= 0.127).

DISCUSSION

This study has demonstrated an association between abdominal fatness and lipid biomarkers among non-obese adults, with WHpR showing the best correlation considering its mean value being higher than the classified risk values (Kuba et al., 2013). This association was only noticed in the male participants not females, studies in the past have shown similar results and it has been suggested to be an indication that the distribution of fat deposits in men may be a better predictor of cardiovascular diseases, metabolic abnormalities and frequent macrovascular complications than the degree of obesity alone (Choi et al., 2002, Matsushita et al., 2012) and might be at higher risk than women.

Also, waist circumference (WC) showed a multivariate

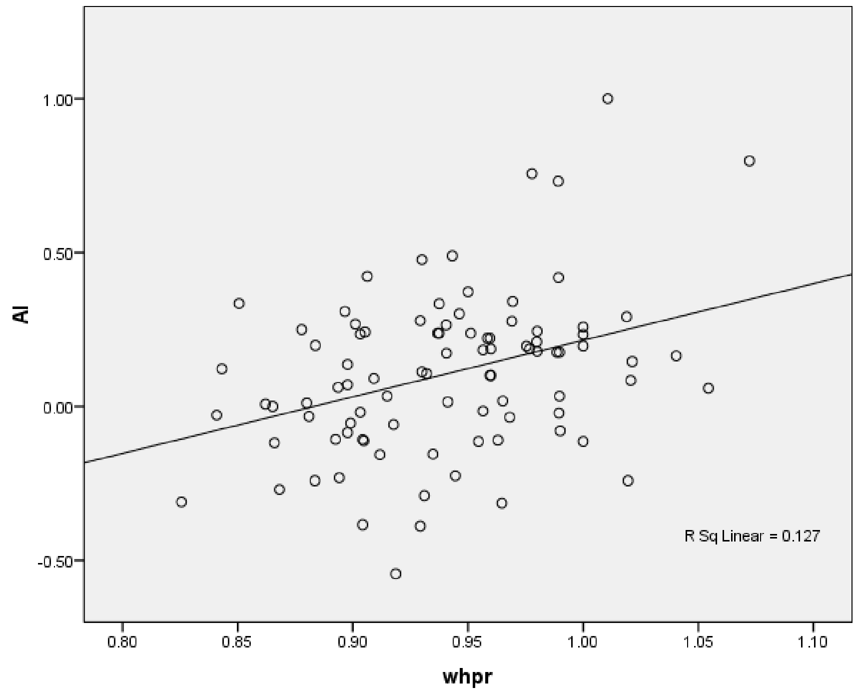

Figure 1. Relationship between atherogenic index (Log [TG/HDL]) and waist-hip ratio (Male).

correlation with TG (0.013*), TC (0.003*), LDL (0.012*) and Log (TG/HDL) (0.016*). But the stronger correlation of WHpR with Log (TG/HDL) (0.001**) could be explained as the inability of WC to discriminate between the morphology of an enlarged abdomen with inappropriate small hip size or short stature (Ahmet et al., 2008, Kayode et al., 2009).

The strong correlations of Log (TG/HDL) with abdominal fatness compared to other atherogenic indices that is, (TC/HDL and LDL/HDL) in this study has exhibited the statistical reliability of Log (TG/HDL) as a tool in the assessment of cardiovascular risk factors, its correlation with lipoprotein particle size may explain its high predictive value (Khazaal et al., 2013). Log (TG/HDL) has been proposed to be a strong predictor of myocardial infarction (Gaziano et al., 1997). Similarly, Khazaal et al. (20130 explained further that an isolated elevation in TG increases coronary heart disease risk but could be counteracted by the level of HDL. The relationship of TG and indices of obesity in this study further revealed the clinical implication and significance of Log (TG/HDL) as a strong biomarker among non- obese. This relationship has been exhibited in previous studies of obese adults (Tanko, 2005). Insulin resistance has been mentioned to be responsible (Shamai et al., 2011) and its contribution to cardiovascular risk has been emphasized (Behan and Mbizo, 2007). TG has also been described to play a role in regulating lipoprotein interactions and not as independent risk marker and proposed to be a major determinant of cholesterol esterification and HDL remodeling in human plasma (Dobiasova et al., 2011).

The sex difference in the development of cardio-metabolic risks among non-obese adults has been attributed to low serum sex-hormone-binding-globulin, low total testosterone and symptomatic androgen deficiency and may provide early warning signs for cardiovascular risk and consequently an opportunity for early intervention in non-obese men (Varant et al., 2006). Generally, the hormonal environment plays a key role in determining body fat distribution. This is because, sex hormones are known to affect regional fat deposition, and the changing of hormonal environment during puberty may contribute to the development of sex differences and large individual changes in fat distribution (Goran and Gower, 1999).

Conclusion

In this study, waist-hip ratio was found to be the most important and consistent index of adiposity that is associated with the atherogenic index (Log [TG/HDL]) in male and no relationship was shown in female non obese adult group. This could be an indication that the distribution of fat deposits in non- obese men may be a better predictor of cardiovascular diseases, metabolic abnormalities and frequent macrovascular complications than the degree of obesity alone and might be at higher risk than women. The strong correlations of Log (TG/HDL) with abdominal fatness compared to other atherogenic indices that is, (TC/HDL and LDL/HDL) in this study has exhibited the statistical reliability of Log (TG/HDL) as a tool in the assessment of cardiovascular risk factors among non-obese adults.

Conflict of interest

The author declares that he has no conflicts of interest.

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