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Association between Anthropometric Indices, Plasma Insulin, Lipids and Lipoproteins in Overweight and Obese Nigerians

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Authors' contributions

This work was carried out in collaboration between all authors. Author MOE was invovled in the conception, design, data analysis and final intellectual drafting of the manuscript. Author AOA was involved in the design, data collection, analysis and drafting of themanuscript. Author OOO was involved in the design, data analysis and intellectual drafting of the manuscript.

Original Research Article

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ABSTRACT

AIM: The aim of this study was to determine the relationship between excess body weight gain and plasma insulin, lipid profile and anthropometric indices in overweight/obese civil servants urban city dwellers in Nigeria where fast food outlets are fast growing.
Study Design: This study was designed to access anthropometric indices, plasma lipid profile and insulin in non diagnosed disease overweight/obese individuals.
Place and Duration of Study: The study was carried out in the Department of Chemical Pathology University College Hospital Ibadan Nigeria, between February 2010 and June 2011.
Methodology: Ninety (90) male and female subjects consisting of sixty overweight/obese with mean age of 36.38±1.04 years and thirty normal weight with mean age of 35.93±1.73 years served as controls. Anthropometric indices were measured using

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standard procedures. Plasma total cholesterol (TC), high density lipoprotein cholesterol (HDLC) and triglyceride (TG) were estimated using biochemical procedures. Insulin was measured with the Ultrasensitive Insulin assay on the Access® immunoassay system. The low density lipoprotein cholesterol (LDLC) was calculated.
Results: The results showed increased plasma insulin (P=.031), TC (P=.004), TG (P=.008) and LDLC (P=.001), BMI (P=.005), weight, waist and hip circumferences (P=.000) were significantly increased compared to the corresponding control values. Insulin was significantly correlated with BMI (r=.403, P=.003) body weight (r=.464, P=.001) and height (r=.380, P=.02) in overweight/obese subjects.
Conclusion: Our results suggest that risk factors for cardio metabolic syndrome exist in overweight /obese civil servants urban city dwellers that have no known diagnosed diseases.

Keywords: Insulin; cholesterol; obesity; anthropometric; metabolic syndrome.

1. INTRODUCTION

The concept of metabolic syndrome (MS) encompasses a series of conditions, whose phenotype is characterized by obesity, insulin resistance, diabetes and hypertension [1]. Prospective studies of adults indicated that central obesity confers an increased risk for type 2 diabetes mellitus (DM) and cardiovascular diseases (CVD). These metabolic abnormalities co-existing with overweight and obesity are risk factors for CVD and major pandemic health problem worldwide [2]. Obesity at an individual level results from energy imbalance—too many calories in, too few calories burned. Although the precise mechanisms underlying this relationship remain controversial, reports have shown that obesity is related to hyperinsulinaemia or insulin resistance in many populations [**3**-4]. The food and physical activity choices that individuals make are shaped by the world in which they live. Due to globalization, the world is getting wealthier, and wealth and weights are linked. “Modern habits associated with obesity” [5]—watching television, buying processed foods at supermarkets and eating more food away from home are rising in Nigeria. According to World Health Organization over 300 million people are clinically obese worldwide [6].In adults, obesity and hyperinsulinemia are also associated with dyslipidemia with or without diabetes [7] furthermore, overweight people without overt diabetes frequently develop a cluster of these abnormalities [8].

Available evidence suggests a link between increased upper body fat distribution, insulin resistance and the expression of the insulin resistance syndrome (IRS) [9]. Whether skeletal muscle insulin resistance or upper body fat is primarily responsible for IRS is not known but clearly both seem to be integral to the pathogenesis of the insulin resistance syndrome. Report from the Framingham study [10] has suggested an increased incidence of cardiovascular events with increasing weight in both men and women. Body weight and mortality rate were directly related in the Harvard Alumni Health Study and weight gain was found to be a significant risk factor for development of diabetes mellitus in women [11]. The association of obesity with the insulin resistance syndrome and cardiovascular risk is not only related to the degree of obesity, but also was thought to be dependent on body fat distribution as well [12-13]. Study on the association between insulin and anthropometric indices as well as plasma lipid changes in apparently healthy (non diagnosed diseases) individuals with excess body weight are rare in Nigeria where fast food outlets are on the increase. Available studies in Nigeria are mainly on the elderly with cardiovascular disease [14-15].

The aim of this study was to determine whether there was relationship between excess body weight gain and one or more of the components of metabolic syndrome (MS) in the development of diabetes or CVD in nondiagnosed disease urban city dwellers in Nigeria where fast food outlets are fast growing. Most of these outlets serve pastry (such as pies, cookies burgers), fried meat and chickens as obtained in the industrialized countries where the usual risk factors of obesity and physical inactivity are rampant [5].

2. MATERIALS AND METHODS

2.1 Subjects

Ninety (90) male and female apparently healthy urban city dwellers who have no diagnosed diseases (renal disease hypertension, diabetes cardiovascular diseases and liver disease) were selected for this study. They consisted of sixty overweight/obese (Obesity>BMI of 30 kg m^{-2}) subjects with a mean age of 36.38±1.04 years and thirty normal weight age matched controls with a mean age of 35.93±1.73. Health status was determined based on self-rated health measured.

They were not on any drug before taking part in the study. Data on demographic and lifestyle variables were obtained using standard questionnaire as adopted from earlier study [16]. The proportion of male to female is 29:31 in overweight/obese and 15:15 in control group. The target population was mainly civil servants urban city dwellers that are overweight or obese.

2.2 Ethical Considerations

The local Ethics Committee of the University of Ibadan/University College Hospital Ibadan, Nigeria, approved the protocol for the study. Informed consent was obtained from all participants prior to the commencement of the study. Ethical approval and informed consent were required for this study.

2.3 Measurement of Physical Parameters

The body weight of each subject was measured in light clothing without shoes to the nearest 0.1 kg using a weighing scale standardized against a fixed weight at every five readings. Height was measured to the nearest centimeter using a rigid calibrated meter rod. Circumference sat the waist (level of the umbilicus) and hip (level of the maximum extension of the buttocks) were measured with a non stretchable tape to the nearest 0.1cm. Normal male waist circumference is <94cm, female waist circumference <80cm. Body mass index was calculated as weight in kilograms divided by height in meters squared [17]. The waist/hip ratio was calculated.

2.4 Classification of Obesity Using WHO Criteria

Normal body weight=18.5-24.9kg/m^2
Overweight=25.0 -29.9kg/m^2
Obese I=30.0-34.9 kg/m^2
Obese II=35.0-39.9 kg/m^2

2.5 Blood Sample Collection

Venous blood was collected from each subject after an overnight fast of 10-14 hours. The blood samples were dispensed into fluoride oxalate bottles (glucose estimation), lithium heparin bottles (insulin estimation) and EDTA bottles (lipids and lipoproteins estimation) respectively and centrifuged at 3000 rpm for 5 minutes. The separated plasma samples were stored frozen at -20ºC until assayed. Plasma glucose concentrations were measured using the glucose oxidase method [18]. Total cholesterol was measured using enzymatic method of Allian et al. [19] and HDLC was estimated after precipitating out LDLC and VLDLC using heavy metals and the supernatant was estimated for HDLC using the method of Allian et al. [19]. The enzymatic method of Bucolo and David [20] was used in the determination of triglyceride. The LDLC was calculated using Friedwald et al. formula [21].

Plasma insulin concentrations were measured with the Ultrasensitive Insulin assay on the Access® immunoassay system (Beckman Coulter). This is a double sandwich immunoassay with no cross-reactivity with proinsulin or C-peptide. The inter assay CVs for controls at 92 and 285 pmol/L (Lyphochek® Immunoassay Plus Control, levels 1 and 2; Bio-Rad) were 4.1% and 5.0%, respectively (n=24 at level 1 and n=23 at level 2). Duplicate measurements of a systematic random sample of 1 in 20 specimens, analyzed1 week apart, showed a median CV across specimens of 3.1% (5^{th} and 95^{th} percentiles, 0.3% and 13.5%; n=116) Accuracy and precision of biochemical tests were monitored by including commercial quality control samples within each batch of test assay.

2.6 Statistical Analysis

Student's t-tests were used to compare mean values. Associations among variables were assessed with the spearman correlation coefficients. Analysis of variance was also performed for within group variations.

3. RESULTS

Table 1 shows mean ± standard error of biophysical and biochemical parameters in all subjects. There were significant increases in body weight (P=.001) waist, hip and BMI (P=.000) height (P=.017) in overweight/obese when compared with the corresponding control values. Significant increases were obtained in plasma TC (P=.004), TG (P=.008), LDLC (P=.001) and insulin (P=.031) in overweight/obese when compared with the corresponding control values. The overweight or obese participants tended to have higher mean plasma glucose but this was not statistically significant (P=.093). Other parameters including the plasma HDLC, waist/hip (P=.765), HDLC/TC (P=.238) and LDLC/HDLC (P=.630) showed no significant changes.

Table 2 shows the mean ± standard error of the biophysical and biochemical parameters in male overweight/obese and male controls. Significant increases were obtained in body weight, hip circumference and BMI (P=.000), plasma TC (P=.045), insulin (P=.016), LDLC (P=.008), LDLC/TC (P=.009) when compared with the male control values. Significantly decreases were obtained in HDLC/TC (P=.009) and insulin (P=.016) in male overweight/obese compared with the corresponding male values. No significant changes were observed in TG (P=.113) and HDLC (P=.148). No significant changes were obtained in all the parameters in males versus females overweight/obese as well as female overweight/obese and control females.

Table 1. Biophysical and biochemical parameters in overweight/obese and controls (mean±S.E)

Variables	Overweight/ Obese N=60	Controls N=30	t-values	P-values
Age (years)	36.38±1.04	35.93±1.73	0.236	.814
Body weight (kg)	84.15±1.47	65.77±1.21	8.407	.001
Height (m)	1.67±0.01	1.69±0.01	-1.178	.017
BMI (kg/m^2)	29.95±0.41	22.94±0.27	11.969	.000
Waist circumference (cm)	98.19±1.51	89.73±1.12	3.847	.000
Hip circumference (cm)	111.83±0.84	102.73±1.25	6.240	.000
Waist/Hip	0.88±0.01	0.87±0.01	0.300	.765
Glucose (mg/dl)	99.22±10.59	74.73±1.56	1.697	.093
TC (mg/dl)	154.98±5.59	129.20±5.75	2.967	.004
TG(mg/dl)	75.67±4.31	58.13±3.77	2.710	.008
HDLC (mg/dl)	42.53±1.86	42.23±2.48	0.095	.925
LDLC (mg/dl)	98.87±4.54	74.70±4.99	3.369	.001
Insulin (pmol/L)	69.82±15.0	24.16±5.44	2.199	.031
HDLC/TC	0.30±0.21	0.33±0.02	-1.189	.238
LDLC/TC	2.32±0.01	1.77±0.02	1.881	.630

TC=Total cholesterol, TG=Triglyceride, LDLC=Low density lipoprotein
HDLC=High density lipoprotein

Table 2. Biophysical and biochemical parameters in overweight/obese by gender (mean±S.E)

Variables	Overweight/obese (Males) N= 28	Control(Males) N=15	t-values	P-values
Age (years)	39.67±1.47	38.50±1.97	0.478	.636
Weight (kg)	88.08±2.54	65.40±1.91	6.371	.000
Height (m)	1.71±0.01	1.71±0.02	-0.220	.827
BMI (kg/m^2)	30.22±0.69	22.32±0.41	8.5099	.005
Waist (cm)	99.13±2.92	88.80±1.54	2.646	.000
Hip (cm)	110.17±1.23	102.27±1.32	4.221	.000
Waist/Hip	0.90±0.03	0.87±0.01	0.986	.331
Glucose (mg/dl)	90.54±5.41	77.80±2.10	1.802	.080
TC (mg/d)l	157.04±9.02	130.13±7.65	2.079	.045
TG (mg/dl)	78.46±7.45	61.13±6.25	1.624	.113
HDLC (mg/dl)	38.75±3.11	46.18±3.90	1.476	.148
LDLC (mg/dl)	102.04±7.77	70.67±6.86	2.791	.008
Insulin (pmol/L)	52.38±10.49	17.39±5.20	2.515	.016
HDLC/TC	0.26±0.02	0.35±0.03	2.750	.009
LDLC/TC	2.74±0.02	1.52±0.31	2.783	.009

TC=Total cholesterol, TG=Triglyceride, LDLC=Low density lipoprotein
HDLC =High density lipoprotein

Table 3 shows mean ± standard error of the biophysical and biochemical parameters in overweight/obese, obese I and II. The lowest level of mean Plasma HDLC was obtained in obese class II. Significant changes were obtained in body weight (P=.000), Hip (P=.012) and LDLC/TC (P=.045) within the groups. The post hoc tests showed significant changes in the body weight, hip circumference and LDLC/TC between obese I and II suggesting an uneven

distribution within the groups. As the BMI increases these parameters increases while insulin decreases.The Spearman correlation of all parameters in overweight/obese subjects shows significant correlations between plasma insulin and BMI (r=.403, P=.003) body weight (r=.464, P=.001) and height(r=.380,P=.02) respectively. Age was significantly correlated with waist circumference(r=.479, P=.019) and height correlated with weight (r=.636, P=.000). TG was significantly correlated with waist circumference (r=.494 P=.009) and LDLC (r=.580, P=.000).

Table 3. Biophysical and biochemical parameters in overweight obese i and obese ii (mean±S.E)

Variables	Overweight (BMI= 25-29.9kg/m^2) N=30	Obese1 (BMI= 30 -34.9kg/m^2) N = 22	Obese I1 (BMI= 35-39.9kg/m^2) N =8	F-values	P-values
Age (yrs)	35.90±1.44	36.14±1.58	43.00±4.73	1.170	.39
Weight (kg)	79.23±1.58	87.36±1.55	109.67±6.33	21.419	.000
Height (m)	1.68±0.07	1.66±0.01	1.69±0.05	1.1948	.167
Waist (cm)	97.13±2.41	100.19±1.72	94.67±3.33	0.618	.790
Hip (cm)	109.87±1.20	115.19±0.84	108.00±3.06	6.321	.004
Waist/Hip	0.89±0.02	0.87±0.01	0.88±0.02	0.158	,980
Glucose (mg/dl)	82.70±2.30	122.55±25.76	93.33±17.49	1.683	.150
TC (mg/dl)	153.03±7.74	161.41±8.93	127.33±10.37	0.962	.097
TG (mg/dl)	75.63±6.86	77.54±5.38	62.33±5.78	0.291	.142
HDLC (mg/dl)	45.90±2.61	39.59±2.64	30.33±6.66	2.742	.074
LDLC (mg/dl)	91.53±7.08	110.82±5.09	84.67±7.33	2.491	.060
Insulin (pmol/L)	70.87±25.88	70.79±13.42	52.22±15.01	0.038	.910
HDLC/TC	0.32±0.02	0.27±0.04	0.24±0.01	0.726	.820
LDLC/TC	2.02±0.02	2.79±0.06	3.02±0.01	3.594	.035

TC=Total cholesterol, TG=Triglyceride, LDLC=Low density lipoprotein
HDLC=High density lipoprotein

4. DISCUSSION

The subjects studied were age matched apparently healthy overweight/obese and normal weight individuals without any diagnosed diseases. The sex distribution showed male: female overweight/obese subjects as 29:31 and controls as 15:15. The body weight, BMI, hip and waist circumferences were increased among the overweight/obese and these were also significantly correlated with plasma insulin. An increased in waist circumference has been associated with risk of CVD in some studies [22-23]. This change may be attributed to excessive accumulation of energy in the form of body fat from increased nutrient intake and relative greater reduction in energy expenditure as well as lack of physical exercise. Previous study [2] showed that overeating and lack of physical exercise could lead to overweight and ultimately obesity.

The graded increase in plasma insulin level parallels the increased BMI, an indication of strong influence of BMI changes on insulin. The major underlying cause may be excess body weight or obesity and their links to several other major disorders. Study has shown that elevated plasma insulin concentrations enhanced VLDL synthesis leading to hypertiglyceridemia, progressive elimination of lipid and apoproteins from VLDL particle leads to increased IDL and LDL both of which are anthrogenic [24]. Insulin independent of lipids is known to be anthrogenic [25]. The plasma TC, TG, LDLC and LDLC/TC were

significantly elevated in the overweight/obese individuals, changes which persisted even after applying confounding factors such as gender and lifestyle. Cigarette smoking and alcohol consumption are uncommon in the subjects as obtained from the questionnaire. The HDLC: TC ratio was reported as a useful and simple index of Ischaemic heart disease risk in men in the Quebec Cardiovascular Study [26]. It is proposed that the ability of this ratio to predict risk could be explained by the fact it is a relevant cumulative marker of the cluster of metabolic abnormalities found in individuals with high TG-low HDLC dyslipidaemia [27].Although the plasma HDLC in this study decreases with increasing body weight, this change was however not significant. The desirability of raising HDLC is based on multiple lines of evidence; perhaps the most direct argument is that there is an increase of about 2.5% in CVD risk for each mg/dl decrease in HDLC level [28].

Previous studies have revealed that insulin resistance and hyperinsulinemia are conditions known to be associated with hypertriglyceridemia and low plasma HDLC concentrations [29-30]. The presence of hyperinsulinemia in fasting subjects may serve as a relevant marker for other metabolic and haemostatic disturbances. Since an insulin-resistant, hyperinsulinemic state increases the risk of type II diabetes mellitus characterized by high triglycerides, low HDLC particles and increased LDLC, it could be inferred that excess body weight would be a strong index for developing metabolic syndrome in these subjects, if a process of vigorous reduction in body weight is not applied. Clearly increased obesity is associated with insulin disturbance. Furthermore, elevated plasma insulin antedates the development of diabetes and places individuals at increased risk of future diabetes.

Early identification, treatment and prevention of metabolic syndrome will be of immense benefit for a society face with an epidemic of overweight and sedentary lifestyle.

Consumption of fast foods and “modern habits associated with obesity” watching television, buying processed foods at supermarkets and eating more food away from home as obtained in industrialized countries should be curtailed to reduce diseases associated with excess body weight and therefore enhancing life longevity.

Self-reported information on lifestyle factors showed that participants did not engage in alcohol consumption or cigarette smoking and these are not common habits in the environment under study and so could not be considered as confounding factors.

When sex was controlled for, the difference in parameters were unaffected in the females but substantially differed in the males. This non significant in females may be due to the female age group studied in part. It is plausible that the gender differences in male and female may have reflected this difference as these biochemical parameters may not alter significantly in premenopausal women since oestrogen is known to enhance HDLC which is considered to be arthroprotective.

Obese subjects are more likely to have diabetes, hypertension and heart disease than those with healthy weights. Based on the present findings, it could be speculated that obese male are more likely prone to metabolic syndrome than females of similar age group in Nigeria. If adequate levels of plasma insulin concentrations are maintained through proper diets, exercise habits and healthy lifestyles, it will prevent the development of type II diabetes as well as reduce the risk of heart disease.

There are a number of limitations in our study methods. First, the self-reported health behaviors were not assessed retrospectively. Literature on the accuracy of self-reported

health behaviors suggests that most people report honestly for behaviors that are not illegal, the biases that do exist are in the direction of underreporting negative health behaviors [31]. Second the sample size of the obese classes was rather small to make a firm conclusion and therefore further study is required on large sample size. Thirdly dietary recall was not considered.

5. CONCLUSION

Our results suggest that risk factors for cardio metabolic syndrome exist in overweight /obese civil servants urban city dwellers that have no known diagnosed diseases.

CONSENT

All authors declare that 'written informed consent was obtained from all participants prior to the commencement of the study.

ETHICAL APPROVAL

The local Ethics Committee of the University of Ibadan/University College Hospital Ibadan, Nigeria, approved the protocol for the study.

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COMPETING INTERESTS

There are no conflicting interests among the authors.

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