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Prevalence, Anthropologic and Biochemical Assessment of Undergraduate Students Predisposed to obesity, diabetes and hypertension in South-East Nigeria.

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Abstract— Metabolic syndrome resulting in associated metabolic abnormalities such as obesity and adiposity has become a global epidemic over the past few decades due to unhealthy dietary habits, malnutrition and reduced physical activity. Diabetes and Hypertension are quite common among obese individuals and there is a linear relationship between the degree of obesity and these diseases. Obesity or excess adiposity resulting from metabolic syndrome is associated with diabetes and cardiovascular disease risk factors such as hypertension. This study was undertaken to assess undergraduate students predisposed to obesity, diabetes and hypertension, and possibly deduce an adequate adiposity measure in predicting diabetes and hypertension. The study group is composed of 1500 volunteered students aged 18 – 26 years from the Faculty of Basic Medical Sciences, recruited by random sampling method through a well-structured questionnaire. Anthropometric parameters measured include; height and weight, waist and hip circumference and physiological variable; blood pressure (systolic and diastolic), random blood glucose level. The mean results showed no significant ($p>0.05$) difference in the respective parameters measured ranging from age, height and weight, with invariably, significant differences ($p<0.05$) in diastolic blood pressure (DBP) and systolic blood pressure (SBP), and random blood glucose. In males, body mass index (BMI) does not correlate significantly with SBP and DBP. All girth measurements correlated positively and non-significantly with blood pressure ($p>0.05$), with significant difference ($p<0.05$) in random blood glucose (RBG) level, whereas in females, the BMI showed no significant correlation with blood pressure and FBG with respect to age. However, most body girths appeared to predict hypertension and diabetes independent of gender. Assessing these predictors and by extension their molecular basis should be seriously considered when screening members of the public who may be at risk of metabolic syndrome induced obesity related diabetes and hypertension, with keen attention on exercise and a change in lifestyle.

Index Terms— *Adiposity, Diabetes, Obesity, Metabolic syndrome, hypertension.*

I. INTRODUCTION

Obesity is a serious and increasingly prevalent health care problem in modern world. [1]It being a condition that exists when the body's storage of fats (triglyceride) is over expressed, resulting therefore in genetic predisposition as a major risk factor for diabetes and hypertension among other related conditions. The trio of obesity, diabetes and hypertension collectively constitutes 24% of morbidity and mortality risk factor globally.

[2]Obesity as recently the commonest non-communicable health concern in pegging mostly industrialized countries and recently underdeveloped countries (due to malnutrition arising from poverty and conflicts). The abnormal or excessive fat distribution in adipose tissue is much in the extent that health is been impaired.

Past and current studies has shown that obesity assumed an epidemic status with no indication or signs of slowing down. For instance, Ibeneme *et al*. [3] reports that in the United States, a comparative data from survey conducted from 1988-1994, with that done from 1999-2005 revealed a significant increase in the prevalence of obesity and overweight.

Body Mass Index (BMI) is a ratio based on body weight and height. The obtained value is compared to the established standards. [4]BMI is highly correlated with body fat, but increased lean body mass or a large body frame can also increase the BMI. Those who have a Body Mass Index (BMI) of 25 to 29 are considered overweight; those with a BMI of 30 to 39 are obsess; and those with a BMI greater than 40 are extremely obese.

Table I: Classification of obesity using BMI

BMI(kg/m2)		Classification
FROM	**Up to**	
	18.5	Underweight
18.5	24.9	Normal weight
25.0	29.9	Overweight
30.0	34.9	Stage I obesity
35.0	39.9	Stage II obesity
40.0	>	Stage III obesity

Adopted from Nikcevic *et al*. [5].

[3]The increasing prevalence of obesity, especially among females despite dietary modification has often been linked to lack of or reduce physical activity. Since 60% of Nigerian students are female, there is definitely a link between increasing obesity among students and the pandemic nature of the condition especially among females worldwide.

[6]Morbid obesity is a term applied to people who are more than two times their ideal body weight or whose body mass index (BMI) exceeds 30kg/m^2. Another definition of morbid obesity is body weight that is more than 100 pounds greater than ideal body weight. In the United States, where morbid obesity is a rapid growing problem, approximately 65% of people are overweight.

[3]Studies on methods of weight control have shown that more than 60% of individuals who lost weight regained it after abandoning the weight control methods. Exercise was shown to account for only 11.5% weight control, while diet accounts for 46.72%. The combination of different methods remain the most variable option but what some students who are rapidly gaining weight needs to do, is to reduce caloric intake or re-visit their dietary regimen. If students perform their duties in the institution as expected of them, a little more exercise is enough to make them jump obesity and remain healthy.

Obesity has been established as a major risk factor for diabetes, hypertension, cardiovascular disease and some cancer in birth and women other comorbid conditions includes ; sleep apnoea, steoarthritis, infertility, idiopathic intracranial, Gastro – esophaageal reflux and urinary stress incontinence.

[7], [8]*Blood pressure (BP)* is a measure of force exerted by the heart on circulating blood against the walls of arteries and major vessels within the body. The expression of blood pressure result is expressed in numbers of two (systolic and diastolic). The systolic number indicates the vesicular blood pressure when the heart contracts (beats), while the diastolic number indicates the pressure (vesicle) when the heart rests between beats. [8]When such force exerted by the cardiac system becomes excessively high, it results in hypertension. Hypertension is a condition resulting from excessive increase in circulating blood pressure. [9]Hypertension ensues when an individual at rest is diagnosed with a high systolic blood pressure measurement reading (>140mmHg) and a high diastolic blood pressure measurement reading (>90mmHg) consistently at days intervals. [10]High blood pressure is essentially classified as primary or secondary hypertension of which about 90-95% of incidences are primary. Primary high blood pressure can be caused by non-specific lifestyle factors such as; excess salt intake, adiposity, smoking and alcoholism. [11]The rest (5-10%) is categorized as secondary hypertension caused by identifiable reason such as endocrine disorders, chronic kidney disease, narrowing of the kidney arteries, or use of contraceptives. Aging, family history of conditions such as hypertension, diabetes mellitus, kidney disease and other co-existing conditions are some identified non-modifiable risk factors. [12], [13]The rise in the prevalence of hypertension is proportional to a significant increase in obesity within a given population, with associated increase in cardiovascular disease especially amongst geriatrics.

[14]An estimated 1.13 billion people globally are reportedly hypertensive, of which two-third of the hypertensive population living in low (Nigeria) and middle-income countries. According to 2015 reports, 1 in every 4 men and 1 in every 5 women are hypertensive, with associated challenges of under control and morbidity among 1 in every 5 hypertensive persons. [15]Global target is aimed at reduction in non-communicable disease(s) prevalence index of hypertension by 25% by 2025.

[16]In sub-Saharan Africa, hypertension is constitutes a common risk factor for stroke, heart attack, most renal disease, ventricular hypertrophy, arteriosclerosis and blindness due to elevated ocular pressure resulting in glaucoma. [15], [16]Epidemiologically, it is reported that an estimated that 10 to 20 million people are hypertensive in sub-Saharan Africa, though as such is not statistically

reflective of the true burden of high blood pressure in the region.

[17]Hypertension can as well be classified as "resistant" when antihypertensive medications fail to reduce blood pressure to normal levels.

[18], [19]*Diabetes mellitus* is a disease condition associated with problems in levels of the endocrine hormone insulin in response to blood glucose levels. Physiologically, the pancreas releases insulin in response to excess glucose in the blood. The excess glucose is stored up in the liver as glycogen, skeletal muscle and adipose tissue as triglyceride by the action of insulin. [20]Diabetes mellitus is categorized into two major types (type 1 and type 2), which ensues when one of the following occurs;

- If the pancreas does not produce enough or any insulin, also called type 1 diabetes mellitus or insulin dependent diabetes mellitus (IDDM).
- If the body does not respond appropriately to insulin secretion, due to a condition referred to as "insulin resistance" or type 2 diabetes mellitus or non-insulin dependent diabetes mellitus (NIDDM).

Diabetes mellitus is an age long disease estimated to have affected over 18.2 million people of which a third (about 5.2 million) of its sufferers are unaware they are sufferers, while over 40 million people are pre-disposed (pre-diabetes). [21]The global prevalence of type 1 diabetes has risen to a chronic level with exacerbated cases in low income countries like Nigeria in sub-Saharan Africa. According to the report of Geldsetzer, et al. [22], a targeted global plan towards halting the rise in diabetes mellitus, obesity and hypertension by 2025 is highly been considered. Of an estimated 422 million people having diabetes globally, especially in low-and middle-income countries like Nigeria and India, 1.6 million deaths have been attributed directly to these conditions yearly.

Table II: Classification of blood pressure in adults.

Category	**Systolic (mmHg)**	**Diastolic (mmHg)**
Normal	80-119	60-79
High normal (Prehypertension)	120-139	80-89
Stage 1 hypertension	140-159	90-99
Stage 2 hypertension	160-179	100-109
Stage 3 hypertension (Hypertension emergency)	≥180	≥110
Isolated systolic hypertension	≥140	<90
Isolated diastolic hypertension	<140	≥90

Adopted from Chobanian *et al.* [17].

[23]There has been a steady increase in prevalence of these cases in recent past as reported by Center for Disease Control (CDC).

This study examines the level of awareness on health implications of obesity, diabetes and hypertension among undergraduate students in the Faculty of Basic Medical Sciences, Ebonyi State University, Presco campus, Abakaliki, Ebonyi State, South-East Nigeria. This study will serve as a database to advocate and promote weight control activities (e.g. diet control and physical exercise) as part of programs to be implemented by management of institutions.

II. METHOD

A. Research design and area

The research design entails a cross sectional study involving random selection of participants which includes male and female within the age range of 18-26 years. This study estimated obesity using BMI, anthropometric parameters, glucose level and blood pressure status among students in Ebonyi State University, Presco campus, Abakaliki, Ebonyi State, South-East Nigeria. Parameters such as weight and height for BMI, waist and hip circumference, blood pressure (BP) and glucose level were ascertained.

B. Study population


a

The study was conducted on a total of 830 female and 670 male subjects selected randomly out of a total student population of approximately 2500 undergraduates in Presco campus of the University, representing a sample size of approximately 60% of the total undergraduate student population in the Faculty.

C. Data collection

Data collection was done using a set of structured questionnaire, which sought information on, history of obesity, diabetes mellitus and hypertension.

Anthropometric parameters such as blood pressure, height, weight, and waist circumference measurements were obtained following standard procedures. All measurements were recorded in each participants' questionnaire. Blood samples were obtained for biochemical parameters such as random blood glucose estimation which was obtained using a glucometer device (Accu Check Active) and strip for ease and convenience.

D. Inclusion criteria

Consent was sought before recruitment for the study to ensure subjects were age 18 years and above, and without any form of gross anatomical deformities of the arms (to be used for BP measurement), and or lower limb (to be used for height measurement).

E. Exclusion criteria

The exclusion criteria included those who did not grant consent, subjects with gross anatomical deformities of the arms (to be used for BP measurement), and or lower limb (to be used for height measurement).

F. Ethical consideration

Enlightenment awareness on the benefits and potential harm of the exercise were given to all participants. They were also informed of the possibility of using the data obtained for academic purpose and thereafter, their free consents to participate were obtained and each given a copy of a structured questionnaire. Every participant was at liberty to request for a copy of his/her result and those that were observed to be having elevated blood pressure, and/or raised random blood glucose were advised to consult a doctor. They were also informed about their right to withdraw their consent to be part of the study at any point, without any consequence to them in line with the National Institute for Health (NIH) guideline.

G. Measurement procedure

Height and weight were measured in (m^2) and (kg) respectively using a weighing scale and height meter (see fig. 1). The subjects were barefoot, standing in an anatomical position with their heels properly positioned, while weights were obtained as the subject was barefooted and standing in anatomical position with minimal clothing to avoid any form of external impact on the actual weight.

Waist circumference was measured at the narrowest point above the iliac crests, half the distance between the iliac crests and the lower edge of the ribs. Gluteal circumference (hip girth, buttock girth) were measured horizontally in a standing position with feet together, at the level of the greatest protuberance of the buttocks.

Blood pressure was measured using an Omron digital instrument. Triplicate reading of blood pressure was taken from the left arm in 3 minutes intervals, while the subject is properly seated on a chair (see fig. 2).

Fig. 1: Weight (a) and height (b) measurements

Fig. 2: Blood pressure measurement

Fig. 3: Blood glucose measurement

Blood glucose was estimated from fresh capillary blood using a glucometer and strip, commonly adopted for personal use. The meter requires 1-2 microliter (µL) of whole blood. Reading is obtained in approximately 5 seconds after the blood is applied (see fig. 3).

H. Data analysis

Results are presented as mean ± standard deviation (SD). Data obtained from the study was analysed statistically with GraphPad Prism software version 6.00 (GPW6) by descriptive representation and one-way analysis of variance (ANOVA) to establish least significant difference (LSD) and difference between means was considered at a p value < 0.05.

III. RESULTS

A. Anthropometric and biochemical evaluation

The clinical characteristics of the subjects as presented in table 3 shows the mean results of anthropometric and metabolic parameters investigated on the basis of gender. Of all parameters assayed, the waist and hip circumference for males (98.64 ± 0.52 cm and 103.11 ± 0.53 cm) were significantly higher (p<0.05) compared to the females (84.66

± 0.46cm and 96.29 ± 0.51 cm).

Table 3: Anthropometric and biochemical evaluation

Parameters	Female	Male
Age (years)	21.46 ± 0.19	21.31 ± 0.20
BMI (kg/m^2)	30.25 ± 0.50	29.82 ± 0.56
Systolic (mmHg)	110.74 ± 1.00	108.56 ± 1.12
Diastolic (mmHg)	74.71 ± 0.76	73.40 ± 0.88
RBG (mmol/l)	4.64 ± 0.08	4.65 ± 0.10
Waist circumference (cm)	84.66 ± 0.46	98.64 ± 0.52*
Hip circumference (cm)	96.29 ± 0.51	103.11 ± 0.53*
Waist-Hip ratio (cm)	0.88 ± 0.00	0.95 ± 0.00

Results are represented as Mean ± SD of evaluation. Values with superscript (*) are significant ($p \leq 0.05$).

B. Gender based evaluation of BP and RBG levels

The evaluation of association between BP (systolic and diastolic) and RBG results indicates no statistical significant (p>0.05) difference when compared with both genders and the normal reference ranges. However, the females were slightly higher in systolic (110.74 ± 1.00 mmHg) and diastolic (74.71 ± 0.76 mmHg) levels than that of males (108.56 ± 1.12 mmHg and 73.40 ± 0.88 mmHg) (see Table 4).

Table 4: Gender based evaluation of BP and RBG levels

Parameters	Female	Male
Systolic (mmHg)	110.74 ± 1.00	108.56 ± 1.12
Diastolic (mmHg)	74.71 ± 0.76	73.40 ± 0.88
RBG level (mmol/l)	4.64 ± 0.08	4.65 ± 0.10

Results are represented as Mean ± SD of evaluation. Values with superscript (*) are significant ($p \leq 0.05$).

C. Gender based evaluation of BMI, BP and RBG levels

The evaluation results of association between BMI, BP (systolic and diastolic) and RBG indicated no statistical significant (p>0.05) difference when compared with both genders and the normal reference ranges. However, the females were slightly higher in BMI (30.25 ± 0.50 kg/m^2), systolic (110.74 ± 1.00 mmHg) and diastolic (74.71 ± 0.76 mmHg) levels than that of males (29.82 ± 0.56 kg/m^2, 108.56 ± 1.12 mmHg and 73.40 ± 0.88 mmHg) respectively.

Table 4: Gender based evaluation of BMI, BP, RBG levels

Parameter	Female	Male
BMI (kg/m^2)	30.25 ± 0.50	29.82 ± 0.56
Systolic (mmHg)	110.74 ± 1.00	108.56 ± 1.12
Diastolic (mmHg)	74.71 ± 0.76	73.40 ± 0.88
RBG (mmol/l)	4.64 ± 0.08	4.65 ± 0.10

Results are represented as Mean ± SD of evaluation. Values with superscript (*) are significant ($p \leq 0.05$).

D. Age based evaluation of BMI, BP and RBG levels

Age based results of association between BMI, BP (systolic and diastolic) and RBG evaluations indicated no statistical significant (p>0.05) difference in the parameters when compared with the age categories and the normal reference ranges (see Table 5). However, there were slightly higher mean BMI (31.31±0.91 kg/m^2) for 24-26 years, systolic (112.79 ± 1.39 mmHg) and diastolic (75.33 ± 1.16 mmHg) levels than those of 18-20 years (29.73 ± 0.50 kg/m^2, 108.16 ± 1.29 mmHg, 73.90 ± 0.93 mmHg) and 21-23 years (29.97 ± 0.62 kg/m^2, 109.55 ± 1.17 mmHg, 73.66 ± 0.95 mmHg) respectively.

Table 5: Age based evaluation of BMI, BP and RBG levels

Age	BMI (kg/m^2)	Systolic (mmHg)	Diastolic (mmHg)	RBG (mmol/l)
18-20	29.73 ± 0.50	108.16 ± 1.29	73.90 ± 0.93	4.68 ± 0.10
21-23	29.97 ± 0.62	109.55 ± 1.17	73.66 ± 0.95	4.58 ± 0.10
24-26	31.31 ± 0.91	112.79 ± 1.39	75.33 ± 1.16	4.70 ± 0.14

Results are represented as Mean ± SD of evaluation. Values with superscript (*) are significant ($p \leq 0.05$).

E. Gender based evaluation of Hip circumference (HC), Waist circumference (WC), and Waist-hip-ratio (WHR) with BP and RBG levels.

Results of evaluation on association between BMI, BP (systolic and diastolic) and RBG, waist circumference (WC), hip circumference (HC) and Waist/hip ratio (WHR), indicated a statistical significant ($p<0.05$) increase in the WC (98.64 ± 0.52 cm) and HC (103.12 ± 0.53 cm) of males when compared with females and the normal reference ranges (see Table 6).

Table 6: Gender based evaluation of WC, HC, and WHR with BP and RBG levels.

Parameter	Female	Male
Systolic (mmHg)	110.74 ± 1.00	108.56 ± 1.12
Diastolic (mmHg)	74.71 ± 0.76	73.40 ± 0.88
RBG (kg/m^2)	4.64 ± 0.08	4.65 ± 0.10
WC (cm)	84.66 ± 0.46	98.64 ± 0.52
Hip circumference (cm)	96.29 ± 0.51	103.12 ± 0.53
Waist-to-ratio (cm)	0.88 ± 0.00	0.95 ± 0.00

Results are represented as Mean ± SD of evaluation. Values with superscript (*) are significant ($p<0.05$).

IV. DISCUSSION

[24]Emerging attention has been drawn to the association between obesity in relation to diabetes and hypertension in recent times. Irrespective of the severity of these disease (mild or moderate) conditions, their comorbidity in relation to metabolic defect or syndrome tend to pose a significant impact on the development of related diseases such as atherosclerosis. This study demonstrates a possible relationship between the components of obesity, diabetes and hypertension, and their related diseases as well. A holistic evaluation of the parameters as statistically analysed (Mean ± SD) was presented in table 3. The present study evaluated a gender based (female and male) association between blood pressure (systolic/diastolic) and blood glucose (BG) levels. It was observed that while measuring the blood pressure for the first time, most of the respondents were anxious, hence resulting in the consideration of just the second and third readings only during the data analysis. The result (see Table 4) revealed no significant ($p>0.05$) difference in the parameters (systolic/diastolic and blood glucose) considered on the basis of gender. This implies that there was no statistical difference in the mean values obtained for the females and males with respect to BP and BG, indicating a

relationship between both. Furthermore, the association between BMI, BP and BG on the basis of gender was considered, and the results obtained indicates that the females fell within obese condition (30.25 ± 0.50 kg/m^2), while the males were overweight with a mean BMI value of 29.82 ± 0.56 kg/m^2. However, this variation in BMI for the females and males appear not to influence the BP and BG values obtained, as they both fell within their respective normal reference range (see Table 5). The above results is indicative of no statistical mean relationship between the parameters (BMI, BP and BG) as evaluated amongst undergraduate students of the Faculty of Basic Medical Sciences, Ebonyi State University, Presco campus, South-East Nigeria precisely. This finding is in agreement with the studies reported by Molarius et al.[25].

Furthermore, the association between BMI, BP and BG on the basis of age (18-20, 21-23, 24-26 years) was evaluated and the results obtained revealed statistical (p<0.05) differences in the parameters evaluated with respect to age, although those within the age of 24-26 years had the highest BMI (31.31 ± 0.91 kg/m^2), Systolic (112.79 ± 1.39 mmHG), Diastolic (75.33 ± 1.16 mmHG), and BG (4.70 ± 0.14 mmol/l) readings compared to those of 18-20 years and 21-23 years respectively. This is indicative that at the age range of 24-26 years, there is a likely impact of lifestyle and dietary habit/choices on BMI, BP and BG level.

Lastly, a gender based association between BP, BG, WC, HC and WHR were assayed and results of the evaluation showed (see Table 6) a significant (p<0.05) difference in WC, HC and WHR of the females compared to their male counterpart. The mean waist circumference (98.64 ± 0.52 cm) and hip circumference (103.12 ± 0.53 cm) of the males were significantly higher than the respective normal reference ranges (WC: 92.0 cm and HC: 98.7 cm). This result illustrates that males exhibited a higher WC and HC values as compared to the females with recourse to their respective reference ranges, which is in contrast with the study of Ratziu *et al*.[26] whose study was though on liver fibrosis in overweight patients (disease condition).

V. CONCLUSION

The result analysis underlines the associated relationship and suspected existence of undergraduate student population predisposed to metabolic syndrome related obesity and other underlying conditions like diabetes and hypertension in the Faculty of Basic Medical Sciences, Ebonyi State University, Presco campus, South-East Nigeria. The association between obesity, diabetes and hypertension in line with some anthropometric parameters from the study emphasizes the urgent need for lifestyle-based improvement, dietary changes reflective of BMI as an effective therapeutic tool for the maintenance of normal body metabolism and physiology. These findings are relevant to the etiology of obesity, diabetes, hypertension and other related diseases, and their implication for the early prevention and treatment of the relevant lifestyle and diet based conditions.

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Institutional Review Board

The researchers were closely and regularly monitored to ensure compliance in accordance with the National Institute of Health (NIH) Nigeria and Helsinki Declaration guidelines for recruitment of human subjects permissible by the Faculty of Basic Medical Sciences, Ebonyi State University ethics committee with code no EBSU/FBMS/21/0011/24.

Conflicts of Interest

There was no conflict of interest regarding the publication of this paper from the volunteered subjects nor from any other individual directly or indirectly.

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