

Assessment of Body Mass Index and Blood Pressure among University Students in, Enugu, South East, Nigeria

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Abstract:

Background: Body Mass Index (BMI) has been described as a significant predictor of Blood Pressure (B.P) but few studies have demonstrated this association in our environment.

The study aims to determine the pattern of relationship between BMI and blood pressure in our environment

Methodology: Two thousand and ninety six (2096) students in two Universities located in Enugu, South East Nigeria completed the study. The blood pressure, weight and height were measured. Body mass index was calculated as weight in Kilograms divided by height in meters square (kg/m^2).

Results: More females than males were underweight (9.4% versus 4.7%). More males than females were overweight (8% versus 4%). Obesity occurred more in males than females (7% versus 0.9%). Blood pressure parameters increased significantly with BMI ($p < 0.0001$) with higher values in males than in females; (the mean systolic blood pressure $124.88 \pm 10.97 \text{ mmHg}$ versus $114.93 \pm 6.82 \text{ mmHg}$, $P < 0.0001$; the mean diastolic blood pressure was $80.1 \pm 7.2 \text{ mmHg}$ versus $73.36 \pm 6.82 \text{ mmHg}$, $p = 0.035$ and the mean arterial Pressure (MAP) $95.02 \pm 7.78 \text{ mmHg}$ versus $87.2 \pm 9.58 \text{ mmHg}$, $p < 0.0001$).

Conclusion: A significant relationship between BMI and Blood pressure was demonstrated among university students in South East Nigeria.

Key Words: Body Mass Index, Blood Pressure, Age, Sex.

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Introduction

Casual blood pressure is the most frequent measurement undertaken in General and Family medical practice¹. Its association with body weight, built or physique has been

a subject of many studies particularly in developed countries²⁻⁴. It has been noted that lean people tended to have lower blood pressures than fat ones^{5,6}. It has also been observed that increase in weight caused a rise in blood pressure⁷. Several studies have reported a relationship between obesity and hypertension⁸⁻¹⁰. The risk of hypertension developing in a previously normotensive individual has been observed to be proportional to the degree of overweight⁸. In a study carried out by Paffenger *et al*¹¹, high body mass index and less participation in sports or exercise was observed to predispose youths to hypertension in middle age. Stambler *et al*¹², in a study conducted in USA, found that the prevalence of high blood pressure in overweight persons doubled that of normal persons and tripled that of underweight in the 20-39 years of age. Age was found to increase blood pressure more in overweight than in normal or lean people¹⁰.

Body mass index is one of the most accurate ways to determine cardiovascular risk factors⁸. It is used to determine the total body fat in adults. Overweight has been associated with Heart disease, Diabetes, and High blood pressure. Indeed a BMI of 30 and above has been observed to increase the risk of death from any cause by 50 - 150 %¹³.

In 1998, the United States Government brought out new guideline for defining healthy weight and overweight¹³: Underweight = BMI less than $18.5 \text{ kg}/\text{m}^2$, Normal weight = BMI of $18.5 - 24.9 \text{ kg}/\text{m}^2$, Overweight = BMI of $25 - 29.9 \text{ kg}/\text{m}^2$, Obesity I = BMI of $30 - 34.9 \text{ kg}/\text{m}^2$, Obesity II = BMI of $35 - 39.9 \text{ kg}/\text{m}^2$, Obesity III = BMI of $40 \text{ kg}/\text{m}^2$ and above (Extreme Obesity).

The high prevalence rates of non-communicable diseases particularly hypertension in developing countries is gaining much attention. High disease burden has been consistent with global projection from 1990-2020¹⁴. In a study by Tesfaye *et al*¹⁵ in three

countries in geoeologically diverse socio-demographic settings, a significant correlation was demonstrated between body mass index and blood pressure in all the populations. Strongest correlation was observed in Indonesia while weakest correlation was observed in Ethiopia. They also reported higher blood pressure in men than in women, a phenomenon sometimes described as gender dichotomy in blood pressure, which is found among the Caucasians¹⁴. However, a study has contradicted these findings and reported blood pressure and hypertension in women more than in men, an observation which may be described as 'reverse gender dichotomy'¹⁶. Increased BMI and Insulin resistance has been implicated as contributory factors for this findings but the precise pathophysiological mechanism is yet unknown.

The relationship between BMI and blood pressure was for a long time perceived to be strong; a universal finding from majority of the earlier studies suggests that obesity was central to a common pathway linking non-communicable disease risk factors and cardiovascular morbidity¹⁷. This perception has since changed in the wake of increased reports of increased blood pressure and hypertension prevalence rates in lean population¹⁴. Some researchers have described a minimum threshold required for BMI to be positively associated with blood pressure¹⁸, but it is yet unclear whether there is an appropriate threshold below which blood pressure is associated with low BMI¹⁹.

In a survey conducted in United States of America by William Moore *et al*²⁰, American Indians and African Americans were significantly overweight, had higher BMI than Whites or Hispanics and therefore, were at greater risk of developing high blood pressure. In Zaria (Northern Nigeria), in a study among school children, blood pressure was found to rise with age²¹. Urbanization and parental history of hypertension were implicated in the development of high blood pressure in a study conducted among University students²². Blood pressure was found to be frequently elevated in obese children²³. In south East Nigeria, there is paucity of data on the relationship between BMI and Blood Pressure. The present study is, therefore, designed to determine the relationship between BMI and blood pressure in a University (urban) community in Enugu, South East, and Nigeria.

Subjects and Methods

Two thousand five hundred (2,500) students of the University of Nigeria, Enugu Campus and Enugu State University of Science and Technology aged 19 to 38 years volunteered to be used as subjects in this study. Out of this

number, two thousand and ninety six (2096) met the criteria. They were recruited between October 2008 and may 2009. They comprise 1200 males and 896 females. Minimum sample size was calculated based on the formula using proportion since the prevalence of hypertension in other parts of Nigeria varies wildly. No prevalence result was found from the Eastern part where this study was conducted.

Sample size

The sample size was calculated using the sample size formula i.e.

$$\text{Where Minimum sample size (n)} = \frac{Z^2 (P) (q)}{d^2}$$

where Z = 1.96 for 95% confidence interval

p = (estimated value for the proportion of a sample that will be recruited for the study) 0.8 for 80%

$$q = 1 - p$$

$$d = \text{standard error margin} = 0.05$$

$$\text{Therefore, } n = \frac{1.96^2 (0.8 \times 0.2)}{0.05^2}$$

Minimum sample size is 246.

However, in order to improve the power of the study, we increased the sample size to 2,500. This was not difficult to achieve as the cost was affordable by the investigators. Inclusion criteria include a strong desire to participate and those not on any form of medication.

Known hypertensives, those with family history of hypertension and diabetics were all excluded from the study. Also excluded were pregnant women, subjects who smoke, consume excessive alcohol, with renal disorders or any chronic medical disorder. After ethical clearance from the relevant authorities and oral consent, subjects were randomly selected after a lucky dip of yes or no. Questionnaires on health data were distributed to the students. Also detailed medical history and clinical examination was done. Weight and height were measured using Avery Rod Station, Birmingham, England. BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Blood pressure was measured using standard procedure in line with World Health Organization guidelines²⁴ with a functional Accoson's sphygmomanometer whose cuff measured between 14 by 24cm. Measurement was taken between 0900 to 1200 hours each day. The students were adequately briefed; each student was allowed to sit down, remain quiet for 3 minutes before measurement was taken. Using auscultatory method for measuring B.P., Korotkoff's phases 1 and 5 were

used to identify Systolic and Diastolic blood pressures respectively. Two readings were taken at 30 minutes interval and their average determined. Mean arterial pressure (MAP) was calculated using the formula. Prior to measurement of weight, shoes, bags, coats and similar objects were removed.

Statistical analyses; Results were presented as simple percentages. Test for significance was performed using one way degree of variance (ANOVA) and Student's t-test. Multiple comparisons was done using Tukeys post hoc test. Values were considered significant at $p < 0.05$ (Two tailed).

Results

Table I shows the summary of the different variables by sex. It indicates that the total mean values for males were significantly higher ($P < 0.05$) than those for the females in all the variables except Height.

Table II shows that 86.6% of the females and 80.3% of males had BMI values that were within the range of normal weight. 9.4% of the females and 4.7% of the males were underweight. 7% of the males were obese as against 0.9% of the females. Among the underweight and normal BMI categories, the differences in the mean values for both sexes were statistically insignificant ($p = 0.73$ for underweight and $P = 0.25$ for normal weight, but was significant for overweight $P = 0.01$ and obese, $p = 0.02$).

Figure 1 shows that BMI increased with age in males but later dropped after 35 years. No definite relationship was demonstrated between BMI and age of the females. Figure 2 shows that at the same age range, B.P. (SBP, DBP and MAP) were significantly higher in males than in females. Blood pressure followed a similar pattern as BMI; In the males, it increased with age up to 35 years, and then decreased.

Table III shows that BMI gradually increased with B.P in both sexes. As BMI increased, SBP, DBP and MAP all increased, though values in males were consistently higher than in females. In the underweight category, mean B.P values for both males and females were not statistically significant ($p = 0.59$, $p = 0.35$ and $p = 0.39$ respectively for SBP, DBP and MAP). In the normal weight category, SBP, DBP and MAP were significantly higher in males than in females ($P < 0.0001$). In the overweight and obese groups, SBP was not statistically significant ($p = 0.085$) but there were statistically significant differences in the, DBP and MAP ($p = 0.003$, $p = 0.01$) between males and females. In the obese category, statistically significant differences did not occur ($P = 0.14$, $p = 0.26$ and $p = 0.16$ for SBP, DBP and MAP respectively).

Table IV shows that BMI increased with B.P. in both sexes. There was a significant increase in SBP, DBP and MAP as BMI range increased. SBP increased from 114mmHg in the underweight to 120 mmHg, 125.5 mmHg and 131.3mmHg in the normal weight, overweight and obese groups respectively ($p < 0.0001$). DBP increased from 71mmHg in the underweight to 77 mmHg, 82 mmHg and 85.2mmHg in the normal, overweight and obese groups respectively ($p < 0.0001$). MAP increased from 85.3 mmHg in underweight to 91.3 mmHg, 96.5 mmHg and 100.6 mmHg in normal weight, overweight and obese groups respectively ($p < 0.0001$). Multiple comparison with Turkeys post hoc test also showed significant changes ($p < 0.0001$).

Table I: Distribution of the different variables by sex (Mean/SD)

Variable	Male (n= 1200)	Female (n= 896)	P-value
Weight (Kg)	67.50 ± 11.08	58.82 ± 0.059	0.001*
Height (M)	1.74 ± 0.064	1.66 ± 0.059	0.09
BMI (Kg/m ²)	22.15 ± 3.88	21.24 ± 2.74	0.001*
SBP (mmHg)	124.88 ± 10.97	114.93 ± 6.35	<0.0001*
DBP (mmHg)	80.1 ± 7.2	73.36 ± 6.82	0.035*
MAP (mmHg)	95.02 ± 7.78	87.28 ± 9.58	<0.0001*

*Significance 0.05 (2 tailed)

Table II: Distribution of BMI and Sex

Variable	Male(n= 1200)		Female(n= 896)		Both(Male & Female) (n= 2096)	
	N(%)	Mean BMI(Kg/m ²)	N(%)	Mean BMI(Kg/m ²)	N (%)	Mean
Underweight	56(4.7)	17.2 ± 0.5	84(9.4)	17.1 ± 1.1	140(6.7)	17.2 ± 0.9
Normal weight	964(80.3)	21.04 ± 1.8	768(85.7)	21.2 ± 1.8	1732(83)	21.1 ± 1.8
Overweight	96(8)	27.14 ± 1.7	36(4)	28.9 ± 0.8	132(6.3)	27.6 ± 1.8
Obese	84(7)	32.6 ± 2.3	8(0.9)	31.1 ± 0.3	92(4.4)	32.4 ± 2.2
Total	1200(100)		896(100)		2096(100)	

Table III: Gender differences in BMI categories and Blood Pressures

Variable	SBP		DBP		MAP	
	N	Mean	N	Mean	N	Mean
BMI <18.5	56	112.7	84	113.3 ± 4.83	56	72.1 ± 4.3
Underweight						
18.5-24.9	964	124.6 ± 10.9	768	114.7 ± 6.2	964	79.7 ± 7.1
Normal Weight						
25-29.9	96	127.1 ± 9.8	36	121.1 ± 6.9	96	77.2 ± 5.8
Overweight						
30 and above	84	131.9 ± 6.0	8	125 ± 7.1	84	80 ± 1.0
Obese						
					84	101.1 ± 5.7

Table IV: Distribution of BMI and B.P for all categories

BMI (Kg/m ²)	SBP(mm/Hg)	DBP(mmHg)	MAP(mmHg)
<18.5(n=140)	114 ± 8.7	71 ± 5.8	85.3 ± 6.2
18.5-24.9(n=1732)	120.2 ± 10.4	76.9 ± 7.6	91.3 ± 7.8
25-29.9(n=132)	125.5 ± 8.9	81.9 ± 5.8	96.5 ± 6.4
30 and above(n=92)	131.3 ± 6.3	85.2 ± 6.6	100.6 ± 5.7

P<0.0001 (2-tailed)

Figure 1; BMI by age and sex

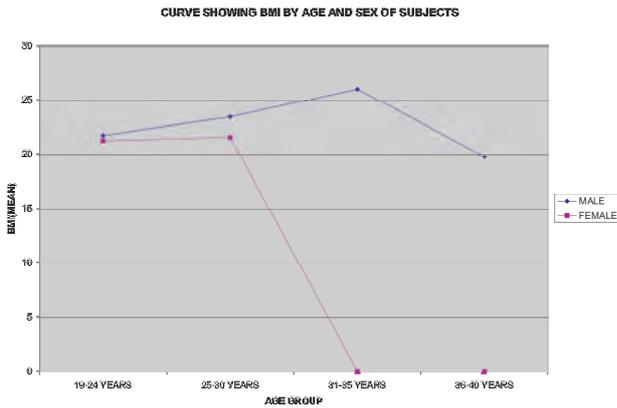
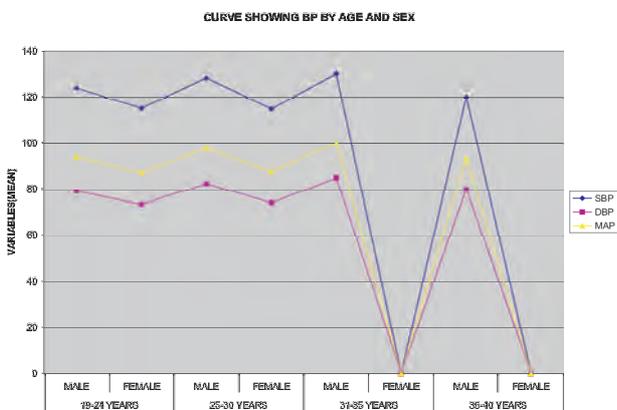


Figure 2; Blood pressure by age and sex



Discussion

In the present study, Blood Pressure (B.P) increased gradually with Body Mass Index (BMI) in both sexes. This is similar to the results obtained by earlier studies^{2,4,25}. This observation could be due to the fact that increase in BMI is associated with increase in blood volume and a corresponding increase in cardiac output and blood pressure⁶. The results of this study also agree with the reports where lean people were observed to have lower blood pressures than fat ones^{5,6}.

The finding in this study where B.P was observed to be strongly associated with BMI and sex is at variance with another study that showed no association²¹. The present study also shows that B.P was also higher in males than in females, a result that is consistent with earlier reports¹⁵, and supports the theory of 'gender dichotomy' in hypertension, but contradicts another finding where women were observed to have higher B.P and BMI in a study using older people²⁶. In another study, using younger people in a rural environment, no significant differences were observed between the male and female population²⁵. Age of the study group and environmental and social factors could be a possible explanation for the observed differences.

In this study, 6.7% and 4.4% of the students were overweight and obese respectively. There was also a direct relationship between elevated BMI and elevated B.P in both sexes. However, a report from a study in United States showed that 46.5% of the students were overweight (BMI =85th percentile)²⁷. Nutritional and environmental factors may be responsible for the higher rate seen in the American students. Indeed, the positive effect of place of residence (urbanization) on B.P has been reported, where B.P was shown to be highest in children living in urban environment²¹.

Kannel *et al*⁶, reported that BMI increased with age and that BMI was highest in those with high diastolic blood pressure. The results of the present study agree with these findings, BMI and B.P were found to increase with age especially in males up to 35 years. This result of increasing BMI with age suggests that B.P also varies with age and could be partly due to the effect of body build especially in the early decades of life as suggested by other workers^{2,8,9}. The correlation shown between BMI and B.P in this study suggests that BMI could be regarded as a significant predictor of blood pressure. A similar pattern was found in White and Black Americans²⁶ and in a rural West African population²⁵.

Results of the present study show that percentage overweight among females was higher than males and this agrees with another report in Nigeria²⁵. However, as earlier reported², obesity was far higher among the males than females. Body build in males and social factors in females may be responsible for these findings. About 86.6% of the females students in this study belong to normal weight; this may be explained by the fact that there is a growing awareness among female Nigerians on the need to maintain their shape and size especially before marriage.

This is the first study in South East Nigeria that evaluated the relationship between BMI and BP among the student population, and was able to demonstrate that gender differences in blood pressure parameters were more pronounced in the normal weight category. This is of immense clinical importance to practitioners managing hypertension in patients with abnormal weight. However, it would have been more appropriate to do same in a rural community, to evaluate the influence of urbanization on BP parameters. Further more follow up of these patients to determine the socio demographic characteristic of those who developed hypertension should have been done to show a clear epidemiological pattern. These short falls will be addressed in a future surveys.

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Author Disclosure statement

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