



Relationship between body mass index and blood pressure amongst energy workers in Lagos metropolis in South-western Nigeria

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ABSTRACT

Background: Incidence of Hypertension (HP) has been on the increase amongst black population. The relationship between Basal Metabolic Index (BMI) and HP has been a subject of discussion for many years with some arguing for and others against its reliability in predicting HP.

Aim: To establish the relationship between BMI and HP using energy workers in Lagos metropolis.

Methods: A study involving Energy Workers of Distribution Sector of Nigerian Energy Industry working within Lagos Metropolis was conducted. Out of 1,548 staff, the study included 928 participants; 282 female and 686 male. An anthropometric based questionnaire was used to obtain their data with no exclusion criteria.

Results: Descriptive statistics shows increase in their mean BMI value that was significantly associated with increase in Systolic blood pressure (SBP) and diastolic blood pressure (DBP) respectively. Using linear regression, BMI could not statistically significantly predict SPB amongst the different groups of workers, $F(1, 871) = 0.963$, ($p = 0.327$). Similarly, using linear regression, BMI could not statistically significantly predict DPB amongst the different groups of workers, $F(1, 871) = 3.067$, ($p = 0.080$) because BMI accounted only for 0.2% of the explained variability in DBP. However, Pearson chi square analysis $p = 0.000$ ($p < 0.05$) shows statistically significant association between BMI of the participants and blood pressure of the study group; $p = 0.000$ ($p < 0.05$). It also shows significant association amongst male and female participants of different age groups.

Conclusion: Increase in BMI level was observed to be significantly associated with increase in SBP and DBP respectively.

INTRODUCTION

Body mass index (BMI) has been established as a veritable means of assessing overweight.[1] Overweight is usually caused by an excess accumulation of body fat considered a risk factor for obesity which is characterized by health issues. Obesity is a common non-communicable disease that more often causes a deterioration in overall health status such as coronary heart disease, ischaemic stroke in which about 21% of ischaemic heart disease is attributable to BMI above 21kg/kg.[2,3] The tool, BMI has been widely used for screening to identify adolescence or children who are obese and by extension enable to predict those at high risk of cardiovascular disease.

Hypertension (HP) is an increase in blood pressure (BP). It is a health condition characterized by blood vessels having persistent raised pressure. Hypertension has been a major public health problem in black population worldwide.[4,5] This ailment shows stages of progression ranging from mild, moderate to severe conditions with the cause and pattern of progression varying markedly. It is believed that majority of hypertensive people live in

developing countries with the number expected to rise in the coming decades due to improved lifestyle. [6] The incidence of cardiovascular diseases especially HP is expected to maintain an upward rise in sub-Saharan African countries particularly in Nigeria because as it were the public health agenda have not focused on this threatening health condition as the region is still grappling with malnutrition and parasitic diseases coupled with unstable economic climate. Nigeria with its large black population, has very high prevalence of HP that range from rates of 8-10% in the rural population to 10-12% for the urban population.[7-9] It is obvious that the figure may have significantly risen in our existing time due to improved socio-economic activities coupled with rapid increase in urbanisation in the last two decades. HP under consideration is still poorly described, frequently underdiagnosed and undertreated in Nigeria.

The relationship between BMI and HP has attracted a lot of research interest worldwide.[10] There are documented reports on Caucasians that showed positive association between BMI and HP.[11-14] Similarly on blacks' population study, relationship between BMI and HP has been

established based on published reports on the effects of generalised obesity defined by BMI.[15,16] A study also showed some other anthropometric or biological variables and social factors on risk of high blood pressure among Nigerians.[17]

Nigeria energy workers (electricity) encompasses the work force responsible for the generation, transmission and distribution of electricity to all parts of the country and beyond. These were formally workers of federal government parastatal known as Nigerian Electric Power Authority (NEPA). Following restructuring in the power sector in a bid to achieve greater efficiency in power supply the name was changed to Power Holding Company of Nigeria (PCHN) before its distribution outlet was privatised. The energy workers that was investigated was one of the two Electricity Distribution Company responsible for electricity distribution to Lagos Island Metropolis and its environs.

There are lifestyle behaviours that could cause deterioration in overall health status of the workforce like unhealthy diet, abuse of alcohol and tobacco coupled with sedentary lifestyle common with white collar workers. These behaviours are known to cause key metabolic/physiological changes like increased blood pressure, overweight/obesity, hyperglycaemia, and hyperlipidaemia.[9] This study was aimed to assess the body sizes and physiological changes of the volunteered staff of EKO Electricity Distribution Company as a means of predicting the lifestyle behaviours that could cause deterioration in their overall health status.

METHOD

A descriptive cross-sectional study involving Energy Workers of the Distribution Sector of Nigerian Energy industry working within the Lagos Metropolis was conducted across the volunteered staff of the company in the month of November, 2019.

Out of a total of 1,548 staff, the study included 928 participants: 282 female and 686 male workers of Age group range from 18-60 years who voluntarily took part in the study. The study was conducted as part of a routine health and wellness screening programme organized by Nigerian Energy workers within the Lagos Metropolis.

Questionnaires were used to obtain anthropometric data from respondents within the company. Due to the metropolitan nature of the area under investigation, diverse varieties of ethnic groups in Nigeria (both minority and majority) were ably represented in the data. The demography elicited in the results are thus seen as reflective and representative of the Nigerian population.

Calibration of anthropometers in centimeters was carefully done. The weighing scale used was calibrated in kilogramme (kg). Age measurements were taken verbally or from respondents in the written questionnaire phase of the project. All measurements were in centimetre (cm).

Anthropometers used for this survey includes the following:

1. Stadiometer: A long rule attached to the wall with a horizontal headpiece- used for measuring height (cm).
2. Tape rule: Used for measuring body circumference (cm).
3. Weighing scale: Used for measuring body weight (kg).

The data collected was analyzed using STATA software version 14.0 and the results of the continuous measurements were presented on Mean, standard deviation (SD) format while results on categorical measurements were presented in Number (%) format. Relation of the study group with body mass index (kg/m²) (an individual's weight in kilogramme divided by the square of height in metre), Systolic Blood Pressure (SBP) mmHg, Diastolic Blood Pressure (DBP) mmHg, and Age distribution was done using Descriptive statistical analysis. Pearson correlation, linear and multiple regression models as well as Chi-square test were used to assess the statistical significance of associations at 5% confidence level.

Study consent and ethical approval

This study was carried out in accordance with the recommendations of the Declaration of Helsinki with written informed consent obtained from all subjects. The study protocol was approved by the Lagos State University Health Research Ethics Committee. LRC/ 06/10/1438.

Written informed consent was obtained having provided necessary identification and study documentation to the company.

RESULTS

Summaries of the descriptive statistics, number of observations, mean and standard deviation (SD) for each variable: BMI, SBP, DBP and Age of the study participants were presented in Table 1.

The study included 928 participants; 282 women and 686 men. The mean (SD) age, was 41.78 (8.47) years. Among the study sample, the mean (SD) BMI was 26.25 (7.48), the mean (SD) SBP was 132.0 (20.0) mmHg, and the mean (SD) DBP was 83.0 (15.0) mmHg [Table 1].

The descriptive statistics in the Table showed the mean values of the parameters that were considered. The result indicated an increase in BMI level that was significantly associated at p- value (0.000) with increase in SBP and DBP respectively on the average range.

Table 1b presented the Model Summary for the regression analysis. The correlation R was 0.033. The coefficient of determination, adjusted R², suggested the relationship was inversely proportional. R², 0.1% of the Systolic Blood Pressure was explained by BMI in the population which suggested an extremely low degree of association.

The ANOVA table presented in Table 1b showed that there was no statistical significance of the regression model that was run (P=0.327) indicating that the regression model did not statistically significantly predict the outcome variable. The coefficient [Table 1b] provides the necessary

Table 1a: Descriptive Statistics of Body Mass Index, Systolic Blood Pressure, Diabolic Blood Pressure and Age of the Study Participants

Variable	Observation	Mean	Std. Deviation
Age	923	41.78	8.47
BM	918	26.2	57.48
Systolic BP	877	132.39	20.02
Diastolic BP	874	83.39	14.58

information to predict SBP from BMI as well as determine whether BMI contributed statistically significantly to the model.

A linear regression established that BMI could not statistically significantly predict SPB amongst the different groups of workers, $F(1, 871) = 0.963$, $p = 0.327$ and hence BMI accounted for 0.1% of the explained variability in SBP of the group. The regression equation was predicted $SBP = 130.122 + 0.088(BMI)$.

Findings presented in Table 2a revealed that the prevalence of stage 1 hypertension (SBP 130-139 mmHg or DBP 80-89 mmHg) was 18.32% (females = 41, males = 129) and the prevalence of stage 2 hypertension (SBP-140 mmHg or DBP-90 mmHg) was 27.69% (females = 40, males = 217).

In addition, 60 participants (6.47%) were underweight (BMI <18.5), 350 participants (37.72%) had normal weight (BMI 18.5-24.9 kg/m²), 314 participants (33.84%) were overweight (BMI 25.0-29.9 kg/m²), and 194 participants (20.91%) were obese (BMI-30 and above or BMI ≥ 30 kg/m²). In summary, 54.75% of the participants exceeded the threshold of normal weight in both sexes being

either overweight or obese.

The result of the Pearson chi square, $p=0.000$ showed that there was a statistically significant association between BMI of the participants as well as between BP of the study group; $p=0.000$

There was also a statistically significant association amongst male and female participants [Table 2b] of different age groups ($p=0.000$), across different religion ($p=0.000$) and at various locations ($p=0.026$). Nonetheless, there was no statistically significant association amongst the group (gender) with regards to the participants employment status ($p=0.563$) [Table 2c].

Table 3 presents the Model Summary for the regression analysis. The R value represents the correlation and it was 0.059. The coefficient of determination R², is the proportion of DBP explained by BMI in the population indicating an extremely low degree of correlation. Only 0.4% of the DBP was explained by BMI. However, to provide a more realistic estimate of the coefficient of determination, the adjusted R² suggested that in actual sense 0.2% of DBP was actually explained by BMI which was relatively very small.

Table 1b: Model Summary for Regression Analysis of Systolic Blood Pressure and Body Mass Index in the Population

R	R Square	Adjusted R Square		Root Mean Square Error	
0.033 [*]	0.001	-0.000		20.032	
ANOVA [†]					
Source	Sum of Squares	DF	Mean Square	F	Sig.
Regression	386.400	1	386.400	0.963	0.327b
Residual	349531.829	871	401.299		
Total	349918.229	872			
SYSTOLIC	Unstandardized	Coefficients	Standardized		
	Coefficients [†]	Std. Error	Coefficients	t	Sig.
			Beta		
(Constant)	130.122	2.435		53.434	0.000
BMI	0.088	0.089	0.033	0.981	0.327

^{*}Predictors: (Constant), BMI

[†]Dependent Variable: SYSTOLIC

Table 2a: Body mass index/ Blood pressure

BMI (kg/m ²)			
Normal	350(37.72)	74(30.58)	276(40.23)
Obesity class	1131(14.12)	43(17.77)	88(12.83)
Obesity class	245(4.85)	27(11.16)	18(2.62)
Obesity class	318(1.94)	12(4.96)	6(0.87)
Overweight	314(33.84)	5(30.99)	239(34.84)
Underweight	60(6.47)	8(3.31)	52(7.58)
Missing values	10(1.08)	3(1.24)	7(1.02)
BP (mmHg)			
Normal	242(26.08)	103(42.56)	139(20.26)
Elevated	193(20.80)	45(18.60)	148(21.57)
HBPI	170(18.32)	41(16.94)	129(18.80)
HBPII	257(27.69)	40(16.53)	217(31.63)
Hypertensive crisis	15(1.62)	1(0.41)	14(2.04)
Missing values	51(5.50)	12(4.96)	39(5.69)

P-value - *significance at $p < 0.05$

Table 2b: Socio Demographic Characteristics

Socio-Demographic variables	Total (n=928) Freq. (%)	Female (n=242) Freq. (%)	Male (n=686) Freq. (%)	p-value
19–32yrs	151(16.36)	64(26.56)	87(12.76)	0.000*
33–46yrs	485(52.55)	132(54.77)	353(51.76)	
47–60yrs	287(31.09)	45(18.67)	242(35.48)	
Missing values	5(0.00)	1(0.00)	4(0.00)	
Total	923(100.00)	241(100.00)	682(100.00)	
Religion				
Christian	741(80.54)	220(91.67)	521(76.62)	0.000*
Islam	179(19.46)	20(8.33)	159(23.38)	
Missing values	8(0.00)	2(0.00)	6(0.00)	

P-value - *significance at $p < 0.05$

Table 2c: Employment status /Location

Contract	183(19.72)	47(19.42)	136(19.83)	0.026*
Permanent	600(64.66)	152(62.81)	448(65.31)	
Status unconfirmed	145(15.63)	43(17.77)	102(14.87)	
Location				
Apapa	85(9.16)	17(7.02)	68(9.91)	0.026*
Festac	32(3.45)	6(2.48)	26(3.79)	
Ibeju	3(0.32)	0(0.00)	3(0.44)	
Ijora	61(6.57)	14(5.79)	47(6.58)	
Island	60(6.47)	9(3.72)	51(7.43)	
Lekki	39(4.20)	5(2.07)	34(4.96)	
Mushin	55(5.93)	11(4.55)	44(6.41)	
Ojo	65(7.00)	20(8.26)	45(6.56)	
Orile	53(5.71)	19(7.85)	34(4.96)	
Unidentified	475(51.19)	141(58.26)	334(48.69)	

P-value

*significance at $p < 0.05$

The ANOVA table reported how well the regression equation fits the data that predicts the dependent variable and this was shown in the table below. There was no statistical significance of the regression model that was run ($p > 0.08$). Overall, the regression model did not statistically significantly predict the outcome variable. The coefficient provided the necessary information to predict DBP from BMI as well as determine whether BMI contributed statistically significantly to the model.

A linear regression established that BMI could not statistically significantly predict DPB amongst the different groups of workers, $F(1, 871) = 3.067$, $p = 0.080$ and BMI accounted for 0.2% of the explained variability in DBP of the group. The regression equation shows; predicted DBP = $80.405 + 0.114(\text{BMI})$.

The result of the Pearson chi square as presented in Table 4a showed that there was a statistically significant association ($p = 0.000$) between the BMI across the different age groups of the participants, more so, there was a statistically significant association ($p = 0.000$) between the BMI and participants employment status. However, there was no statistically significant association between the participants BMI spread across different religion ($p = 0.267$).

Table 4b presents the Model Summary for the multiple regression analysis. It was observed that the explanatory variables; Age, Weight, Height, Employment status, Religion and Gender explain 14.33% of the variability of SBP.

The output from the ANOVA [Table 4b] shows that the explanatory variables statistically predicted the dependent variable, SBP, $F(7, 861) = 20.66$, $p < 0.05$ (i.e., the regression model was a good fit of the data). A multiple regression was run to predict SBP from age, weight, height, employment status, religion and gender [Table 4c]. All three variables; Age, Weight and Height added statistically significantly to the predicted Systolic Blood Pressure, $F(7, 861) = 20.66$, $p < 0.05$, $R^2 = 0.1438$, however employment status and religion did not add statistically significantly ($p = 0.066$, $p = 0.420$) to the prediction, $p > 0.05$.

Estimated model coefficients

The general form of the equation to predict Systolic Blood Pressure from age, weight, height, employment status, religion and gender was: Predicted, $\text{SBP} = 75.827 + 0.5182(\text{Age}) + 0.249(\text{Weight}) - 3.320(\text{Employment status}) - 1.318(\text{Religion}) + 8.388(\text{Gender})$.

Table 3: Model Summary

Table 3. Model Summary					
R	R Square	Adjusted R Square	Root Mean Square Error		
0.059 [*]	0.004	0.002	14.553		
ANOVA [†]					
Model	Sum of Squares	DF	Mean Square	F	Sig.
Regression	649.493	1	649.493	3.067	0.080b
Residual	184265.267	871	211.799		
Total	184914.760	872			
DIASTOLIC	Unstandardized Coefficients	Standardized Coefficients	DIASTOLIC Coefficients	Sig.	
				†Std. Error	
(Constant)	80.405	1.772		45.366	0.000
BMI	0.114	0.065	0.059	1.751	0.080

^{*}Predictors: (Constant), BMI[†]Dependent Variable: DIASTOLIC**Table 4a: Relationship between BMI, Age group, religion and the employment status of the participants**

Variables	BMI Normal	Obesity class 1	Obesity class 2	Obesity class 3	Over weight	Under weight	p-value
19-32yrs	77(22.00)	11(8.46)	4(8.89)	1(5.56)	42(13.38)	16(26.67)	0.000*
33-46yrs	172(49.14)	61(46.92)	28(62.22)	13(72.22)	177(56.37)	29(48.33)	
47-60yrs	101(28.86)	58(44.62)	13(28.89)	4(22.22)	95(30.25)	15(25)	
Total	350(100)	130(100)	45(100)	18(100)	314(100)	60(100)	
Religion							
Christian	275(78.7)	109(83.85)	40(90.91)	16(88.89)	252(80.77)	44(73.33)	0.267
Islam	75(21.43)	21(16.15)	4(9.09)	2(11.11)	60(19.23)	16(26.67)	
Total	350(100)	130(100)	44(100)	18(100)	312(100)	60(100)	
Employment status							
Contract	82(23.43)	13(9.92)	4(8.89)	1(5.56)	66(21.02)	16(26.67)	0.000*
Permanent	213(60.86)	98(74.81)	36(80.00)	14(77.78)	195(62.10)	41(68.33)	
Status Unconfirmed	55(15.71)	20(5.27)	5(11.11)	3(16.67)	53(16.88)	3(5.00)	
Total	350(100)	131(100)	45(100)	18(100)	314(100)	60(100)	

Table 4b: Model Summary

R	R Square	Adjusted R Square	Root Mean Square	Error	
0.379 [*]	0.1438	0.1369	18.568		
ANOVA [†]					
Model	Sum of Squares	DF	Mean Square	F	Sig.
Regression	49870.4379	7	7124.34827	20.66	0.000 [‡]
Residual	296844.506	861	344.767138		
Total	346714.944	868	399.441179		

^{*}Predictors: (Constant), BMI[†]Dependent Variable: SYSTOLIC[‡]Predictors: (Constant), Age, Weight, Height, Employment status, Religion and**Table 4c: Coefficients ***

SYSTOLIC	Unstandardized Coefficients	Standardized Coefficients	t	Sig.
	Coefficients	Std. Error	Beta	
(Constant)	75.827	7.242		10.47 0.000
Age	0.5182	0.085	0.221	6.06 0.000
Weight	0.249	0.0452	0.180	5.51 0.000
Height	6.953	3.521	0.065	1.97 0.049
Employment Status				
Permanent	-3.320	1.795	-0.077	-1.85 0.065
Status unconfined	-4.950	2.418	-0.077	-2.05 0.041
Religion	-1.318	1.632	-0.026	-0.081 0.420
Gender	8.388	1.530	0.185	5.48 0.000

*Dependent Variable: SYSTOLIC

DISCUSSION

This study on the energy workers of the Distribution Sector of Nigerian Energy Industry revealed high incidence of overweight/obesity amongst the work force indicating a cumulative of 54.75% of the total number of the participants. Body mass index which is a fat related variable shows positive correlation in the applied cases with a minimum of 25 kg/m² and above. The descriptive statistics in table 1 shows the mean value increase in BMI level that was significantly associated with increase in SBP and DBP respectively. However, regression analysis of SBP and BMI in the population suggests an extremely low degree of association because of very weak correlation coefficient ($R = 0.033$) between them. In this regard, regression model did not statistically significantly predict the outcome variables. Furthermore, a linear regression established that BMI could not statistically significantly predict SPB amongst the different groups of workers, $F(1, 871) = 0.963$, ($p = 0.327$) between those on permanent and unconfirmed status. Similarly, the proportion of DBP explained by BMI in the population indicates an extremely low degree of correlation ($R = 0.059$). A linear regression established that BMI could not also statistically significantly predict DPB amongst the different groups of workers, $F(1, 871) = 3.067$, ($p = 0.080$) because BMI accounted only for 0.2% of the explained variability in DBP of the group. This analytical report corroborated with a population study in Ethiopia that showed similar weak correlation coefficient ($R < 0.30$) between BMI and SBP or DBP.[10] In this regard, regression analysis was unsuitable analytical model for this study.

The result of this study which shows statistically significant association between BMI of the participants and HP of the study group ($p = 0.000$) was in agreement with reports from previous studies where positive association have been established between BMI and HP.[18-21] This study also exhibited statistically significant association between male and female participants of different age cohorts ($p = 0.000$), across different religion ($p = 0.000$) and at various locations ($p = 0.026$). This agrees with the reports of other population studies.[21-24] However, It could be inferred from the outcome analysis ($p = 0.420$) that the workers religion did not influence their lifestyle behaviours. Similarly, their employment status did not significantly influence their lifestyle behaviours.

The high BMI level observed amongst the larger population of the energy workers could be due to several reasons. The key consideration is the demographic factor. Lagos is the largest cosmopolitan city in West African sub-region with huge infrastructure for the ease of life. Urbanization is intimately associated with socio economic changes which inadvertently affects lifestyle behaviours and overall health status of its citizenry. This manifested in this case with the energy workers investigated. Studies have established linkages between work place/environment to lifestyle behaviours.[21,25,26,27] It was obvious that the environment influenced the energy workers consumption of high calorie foods and also exposed them to other lifestyle behaviours. Besides, urbanization is characterized by increased use of motorized transportation coupled with sedentary type of occupation which altogether may have constituted health burden to the work force.

The high BMI level does not suggest a good

wellbeing because it is intimately linked with hypertension, diabetes, and other non-communicable diseases (NCDs). Therefore, this energy workers should be strongly encouraged to undertake life style changes that can lead to reduction in their BMI level with the aim of reducing cardiovascular morbidity and mortality for increased life expectancy.

CONCLUSION

The study shows that the majority of the energy workers investigated exhibited high BMI level. It was obvious that the dietary pattern and other lifestyle behaviours of these workers were influenced by socio economic changes which might constitute a health risk.

Conflict of interest

Authors declare no conflict of interest relating to the study.

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