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Reviewing of the Relationship Between Body Mass Index and High Blood Pressure of Patients

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Abstract: On average, older adults tend to have more body fat than younger adults for an equivalent BMI. Hence, few works have been carried out on the areas of relationship between Body Mass Index and Hypertension. Therefore, this research is carried out to review the relationship between Body Mass Index and patients with high Blood Pressure at Murtala Muhammad specialist hospital kano state using regression and correlation analyses. The result shows that the conditions of patients with high blood pressure are worsened by excess weight, also the relationship between body mass and systolic and that of diastolic blood pressure were assed to be strong and fairly weak respectively.

Keywords: Body Mass Index, Diastolic Blood Pressure, Systolic Blood Pressure and Height

1. Introduction

The body mass index (BMI) or Quetelet index is a value derived from the mass (weight) and height of an individual. The BMI is defined as the body mass divided by the square of the body height, and is universally expressed in units of Kg/m^2, resulting from mass in kilograms and height in meters. The BMI is attempt to quantify the amount of tissue mass (muscles, fat and bone) in an individual and then categorize that person as ‘Underweight, normal weight, or obese’ based on that value. However there is some debate about where on the scale the dividing lines between categories should be placed. Obesity rates have been increasing over recent decades, causing significant Concern among policy makers. Excess body fat, commonly measured by body mass Index(BMI), is a major risk factor for several common disorders including diabetes and cardiovascular disease, placing a substantial burden on health care systems. To guide effective public health action, we need to understand the complex system of intercorrelated influences on BMI.

Mulatero [1] says Persistence hypertension is one of the risk factors for stroke, heart attacks, heart failure and arterial aneurysm and is a leading cause of chronic kidney failure. Moderate elevation of arterial blood pressure leads to short life. [2] Adolescent obesity is on the rise and is associated with adverse health effects. Excessive body weight, including overweight and obesity, together with hypertension, represents major threats to civilization in the 21st Century. [3] However, the impact of weight gain on BP is neither consistent across age groups, nor is it the same between men and women. [4] Subcutaneous abdominal tissue was more consistently related to CVD risk than peripheral skin folds. Linear correlations between both SBP and DBP for all anthropometric measurements among males were found to be significant in the adult Brazilian men and blood pressure increased with higher BMI, WC, and various skin fold locations. [5] an increase in the dimension of this problem has been reported in the high socio-economic group in India. A study in Delhi revealed even higher prevalence (32-50%)

of overweight (body mass index (BMI) >25) among adults belonging to high income group as compared with 16.2-20% in those belonging to middle income group. The possibilities of various dietary factors, such as reductions in the salt content of food, have also been considered in preventing hypertension [6]. Other nutritional means of lowering blood pressure are the increase intake of high protein diets, traditional diet that consists of a variety of fermented soybean products and vegetable based foods, which are rich sources of bioactive compounds (such as hesperiding) capable of promoting cardiovascular health [7]. Other researchers [1, 8-14] have shown a positive relationship between overweight, obesity, unhealthy lipid profiles, high insulin levels, and hypertension in both children and adolescents, and abstinence from the consumption of processed red meat treated with high sodium and nitrites [15]. Hypertension and overweight could therefore be subjects of major public health concern in Kano State, showing that the intensive medical education about ways to mitigate and prevent hypertension in the region is of a great important.

There are growing evidence that being overweight, or obese has effect in other aspects of life such as health status, job commitment and academic performance. The rise in body size mostly in developed societies among school age children makes the latter particularly pertinent.

2. Materials and Methodology

2.1. Regression

Regression is the techniques used to study the relationship between variables. Linear regression is used for a special class of relationship, those that can be described by straight line. The linear regression technique is applicable in every field of study, such as management science, biological sciences, physics, medical sciences, agricultural science and the humanities and so on. The purpose of fitting a linear regression model is as varied as its applications, but the most common ones are the descriptions of a relationship and the prediction of future variables.

The method of least square can be used to estimate the values of the unknown parameters of the regression model in such way that this least square estimate when fitted to the model provides a line of best of fit to the data. Since the first step in regression is to assume that the relationship between the dependent and independent variable can be fitted by a linear model.

Due to the above reason, we then fit a model to the observations. Now let us consider a linear model below:

$$\hat{Y}_i = \beta_0 + \beta_1 X_1 + e_i \tag{1}$$

It is called simple linear regression model, because it has only one independent variable or regressor.

Where

Y_i is the response variable or dependent variable β_0 is the intercept term

β_1 is the slope coefficient

e_i is the random error term or disturbance term i.e., the distance of individual Y from the regression line, β_0 is the intercept, the value of Y when

$X_1 = 0$ and the β_1, is the slope of the line i.e. the rate of change in Y for a unit change in X.

β_0 and β_1 are called population parameters, which can be estimated using the least square method since they are unknown.

The least square estimators of the intercept and slope in the simple linear regression model are:

$$\hat{\beta}_0 = \bar{Y} - \hat{\beta}_1 \bar{X} \tag{2}$$

$$\hat{\beta}_1 = \frac{n\sum_{i=1}^{n} X_i Y_i - n\bar{X}\bar{Y}}{\sum_{i=1}^{n} X_i^2 - n\bar{X}^2} \tag{3}$$

Where

$\bar{Y} = \sum_{i=1}^{n} \frac{y_i}{n}$ and $\bar{X} = \sum_{i=1}^{n} \frac{x_i}{n}$

The fitted or estimated regression line is therefore;

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x \tag{4}$$

2.2. Correlation Coefficient 'r'

When two continuous variables are measured in the same person, such as weight and height, systolic and diastolic blood pressure, the relationship between the two quantitative measurement or continuous variables is called correlation. The degree or the magnitude of association between two sets of figures on continuous variables such as height and weight is measured in terms of a parameter called correlation coefficient. It is denoted by 'R'. The extent of correlation ranges between (-1) and (+1) and the formula for calculating correlation coefficient between two Variables say X and Y on 'n' subject is:

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \tag{5}$$

Where x is the independent variable, y is the dependent variable and n is the number of observation. It varies from r = 0 which suggests there is no relationship existing between the variables, r =1 which suggests a perfect positive linear correlation or r = -1 which suggests a perfect negative linear correlation.

The correlation coefficient (r) is usually reported in terms of its squared (r^2), which is interpreted as percent of variance.

2.3. Data Collection

The data used for this project was a secondary data, and was obtained from medical record department, Murtala Muhammad specialist hospital, Kano state.

3. Analysis and Discussions

This section deals with the Analysis and Discussion of the collected data considered in the research work. Two linear models were used for testing relationship between the variables.

3.1. Analysis of Body Mass Index VS Systolic Blood Pressure

Table 1. *Estimation of Parameters.*

Predictor	Coef	SE Coef	T	P
Constant	128.03	14.33	8.94	0.000
BMI X	0.9793	0.5565	1.76	0.085
	S = 22.7140 R-Sq = 6.1% R-Sq(adj) = 4.1%			

From above table, it is shows that the percentage of coefficient of determination is low so therefore due to the weak relationship between the dependent variable (systolic) and the independent variables (body mass index), the independent variables explained the dependent variable by only 6.1%, while the remaining 93.9% is explained by some other factors. Also the two coefficients $\beta_0 = 128$ is significant while β_i=0.979 is not significant from zero, since the p-value is greater than level of significant ($\propto$=0.05).

The regression equation is

Systolic = 128 + 0.979 BMI

Table 2. *Significant Difference Between Systolic and BMI.*

Source	DF	SS	MS	F	P
Regression	1	1597.5	1597.5	3.10	0.085
Residual Error	48	24764.5	515.9		
Total	49	26362.0			

Since p=0.085 > $\propto$=0.05 we accept H_0 which said that there is no significant relationship between BMI and Systolic of patient with high blood pressure. Accepting of H_0 leads to rejecting of H_1 which said that there is no significant relationship between BMI and Systolic of patient with high blood. It implies that there is no significance.

3.2. Analysis of Body Mass Index VS Diastolic Blood Pressure

Table 3. *Regression Analysis on Diastolic versus BMI.*

Predictor	Coef	SE Coef	T	P
Constant	79.212	9.795	8.09	0.000
X	0.5694	0.3804	1.50	0.141
	S = 15.5271 R-Sq = 4.5% R-Sq(adj) = 2.5%			

From table above, it shows that the percentage of coefficient of determination is low so therefore due to the poor relationship between the dependent variable diastolic and the independent variables body mass index, the independent variables explained the dependent variable by only 4.5%, while the remaining 95.5% is explained by some other factors. The two coefficients β_0 are significant and β_1 are not significant, since it p-value =0.141> 0.05 level of significant.

Table 4. *Significant Difference Between Diastolic and BMI.*

Source	DF	SS	MS	F	P
Regression	1	540.2	504.2	2.24	0.141
Residual Error	48	11572.3	241.1		
Total	49	12112.5			

Since the p=0.141 value > $\propto$ =0.05, we accept H_0 which said that there is no significant relationship between BMI and Diastolic of patient with high blood pressure. Accepting of H_0 leads to rejecting H_1 which said that there is significant relationship between BMI and Diastolic of patient with high blood.

The regression equation is

Diastolic = 79.2 + 0.569 BMI(x)

Table 5. *Correlation Coefficient between BMI, Systolic and Diastolic.*

Variables	Systolic	BMI
BMI	0.246	
P-value	0.085	
Diastolic	0.652	0.211
P-value	0.000	0.141

From the table above, there exist fair relationships between the systolic blood pressure and the body mass index and that of diastolic blood pressure and the body mass index, since the p values > α -value. Hence, there are no significant relationships between BMI and Systolic blood pressure and that of BMI and Diastolic blood pressure. While there is a significant relationship between Diastolic and that of Systolic blood pressures.

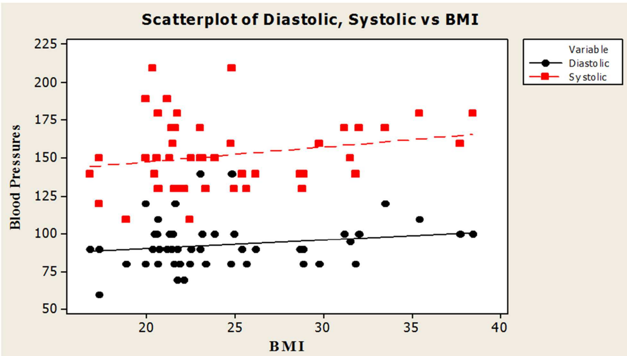

Figure 1. *Plot of Systolic, Diastolic and BMI.*

The graph above shows there is fair relationships between Systolic vs. BMI and Diastolic vs. BMI.

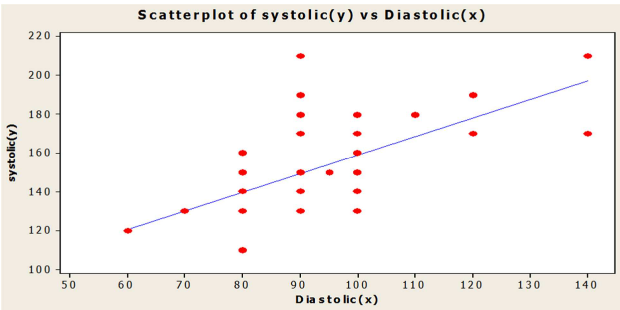

Figure 2. *Plot of Correlation Coefficient for Systolic and Diastolic.*

4. Discussions

From the study and analysis carried out, it has been observed that the condition of patients with high blood pressure is worsened by excess weight and in order for them to become normal they need to work on their weight. The level of salt intake and alcohol consumption were not assessed in this study. Also the diagnosis of hypertension was made based on the two blood Pressure measurements at a sitting. This may have affected the overall prevalence. The models showed the relationship between body mass and systolic blood pressure was strong while on diastolic was fairly weak and the coefficient of determination for the systolic was 6.1% which contributes more than the diastolic pressure with low percentage. The independent variable (BMI) contributed significantly to the level of blood pressure of patients (Systolic) as shown by the coefficient of BMI in table 1. This implies that, increase in BMI may lead to rise in blood pressure (Systolic). The F-statistic which is said to test the general significance of the regression revealed that estimated model can be accepted. The preliminary investigation of the relationship between the two variables (BMI and blood pressure) using the scatter diagram is suggestive of direct linear relationship. That is, when BMI increases, the blood pressure increases, it shows in the figure 2. And the relationship between Systolic blood pressure and BMI is significance while that of diastolic blood pressure and BMI is not significant which lead to rejection of alternative hypothesis for the diastolic pressure. And it has been proved that there exist relationship between Systolic blood pressure and Diastolic blood pressure.

5. Conclusions

Obesity measured in terms of body mass index has been used as the predictor for Hypertension; though BMI is the most common, it may not accurately assess obesity on different patients. This work attempted to capture the true relationship of blood pressure and BMI. We were mainly interested in the significance of BMI as a predictor of blood pressure and the functional form of BMI and blood pressure. The results revealed that BMI has an impact on the level of blood pressure and this falls in line with what have been mentioned in above literature reviews. This study showed that a decrease in BMI has a beneficial effect on blood pressure. We suggest that clinicians look for obesity coexisting with hypertension, and treat such cases to avoid coronary event and other complications of hypertension. Prevention and control of hypertension has a significantly positive impact on the life expectancy. Therefore, weight loss may contribute positively in managing the problem of hypertension.

Recommendations

The following are recommended in order for the patients to become normal:-

i. Watch and control their food intake by eating more fruits, vegetables, food that contain more fiber and vitamin D, eating more fish and avoid much alcohol intake.
ii. They should engage themselves in regular aerobic exercise.
iii. Visit the clinic more frequently and take anti-hypertensive drugs.

Area for Further Research

It is hoped that this research influences others to replicate this work, possibly using other methods. Only when one is willing to question our current practice can one be able to improve on it. Since non-linearity was found between diastolic blood pressure and BMI, a better method should be used when modeling the relationship.

An investigation of the comparison between efficiency of fractional Polynomials and non-parametric methods to determine the best method for modeling the relationship between blood pressure and body mass index.

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