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Modeling Body Mass Index (BMI), Blood Pressure (BP), Age and Sex to Investigate Cardiovascular Problems

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ABSTRACT: *Cardiovascular disease (CVD) is a general term for conditions affecting the heart or blood vessels, usually associated with building up of fat deposits inside the arteries. Majority of individuals with CVD may go about their normal day-to-day schedule of duties without realizing the danger the disease portends. As the severity increases, affected persons become more prone to suffer death. In this study, some risk factors other than family history, diabetes, poor diet, blood pressure and smoking have been investigated. We modeled the relationship between Body Mass Index (BMI) and Age for male and female separately so as to investigate the fluctuations in the proximity to cardiovascular diseases between male and female individuals. Many studies have shown a couple of significant associations between BMI and Age, but in this study, we will like to predict the likelihood of having abnormal BMI with age to bring to the notice when one is due for check up to prevent cardiovascular problems using multivariate logistic distribution. The study reveals a risk tendency of having cardiovascular issues if no proper monitoring is done for females within the age of 20 years and 40 years due to high body mass index.Similarly, the male folks are prone to high body mass index in the early 40's which maintained a high density level as the person moves beyond 55 years before it begin to show some decline as the person age increases from 55 years toward 60 years.*

Keywords: *Cardiovascular disease, Cardiology, Biostatistics.*

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I. INTRODUCTION:

Cardiovascular diseases are disorders of the heart and blood vessels and including coronary heart disease, cerebrovascular disease, rheumatic heart disease and other conditions. According to the World Health Organization (WHO) cardiovascular diseases (CVDs) take the lives of 17.9 million people every year representing 31% of all global deaths. Some of the things which trigger these diseases include tobacco smoking, unhealthy diet, physical inactivity and the harmful use of alcohol. The results of these in people are demonstration of raised blood pressure, elevated blood glucose and lipids, overweight and obesity. Identifying those at highest risk of CVDs is crucial as well as ensuring that they receive appropriate treatment can prevent premature deaths. Available statistics on the prevailing malady show for instance that 48% of American adults (121.5 million) in 2016 had cardiovascular disease (AHA News).

The American Heart Association (AHA) believes that the rise in cardiovascular disease is driven, in part, by changes in the way high blood pressure is defined. In November 2017, the AHA and American College of Cardiology updated the definition of high blood pressure as a reading of 130/80 millimeters of mercury (mmHg), compared to the previous definition of 140/90. Apart from blood pressure, another factor is obesity which according to them "was associated with a shorter lifespan and a greater proportion of life lived with cardiovascular disease. They therefore recommend eating a healthy diet, exercising regularly, avoiding excess weight, not smoking and keeping blood pressure, cholesterol and blood sugar within a healthy range.

As Moye (2016) rightly points out while trying to provide rationale behind statistical applications in cardiology research, "the need for biostatistics in cardiovascular research is ever-present, but investigators continue to be challenged by the implementation of statistical methods. Aptitude in applied statistics is generated by knowledge and experience, yet few health care workers can devote the time required to develop the requisite statistical skill set, a circumstance that generates common statistical mistakes that are fortunately avoidable. The researcher was able to provide an overview of biostatistical procedures available to cardiovascular researchers as they conduct their bench or translational investigations. Some of these include p-value, multiple testing, one sided testing, statistical hypothesis testing, ANOVA, multivariate analysis (MANOVA), etc.

Sarwar et al. (2004) conducted a survey in the rural areas of Peshawar district of Pakistan and found that major causes of ischemic heart disease are excessive consumption of fatty food, sedentary lifestyle, lack of regular exercise and stressful pattern of life. However, the results of this study were based on computing simple

averages of variables and did not include the detailed diet pattern, protein types and other major factors that may be responsible for enhancing the risk of the disease.

Bhatti et al (2006),on the other hand, used logistic regression analysis to investigate factors that contribute significantly to enhancing the risk of ischemic heart disease. The dependent variable of the study is diagnosis (whether the patient has the disease or not). The result shows the factors that contribute significantly to enhancing the risk of the disease are the use of banaspati ghee, living in urban area, high cholesterol level, age group of 51 – 60 years as well as other significant factors like Apo Protein A, Apo Protein B, high density Lipo protein, low density Lipo protein, phospholipids, total lipid and uric acid.

This gives us a basis for our research which involves modeling the relationship between BMI and Age for male and female separately so as to investigate the fluctuations in the proximity to cardiovascular diseases between male and female individuals. Although many studies have shown a couple of significant associations between BMI and Age, but in this study, we will like to predict the likelihood of having abnormal BMI with age as well as BP and age to bring to the notice when one is due for check up to prevent cardiovascular problems using multivariate logistic distribution.

Presentation of Data

The data set comprises of two hundred and fifty four (254) respondents from the University of Port Harcourt that are taking Introduction to Statistics in their 200 level including students and their lecturers.

Table 1: Categorical Frequency Statistics for the Body Mass Index (x) and Age groups of respondents (y).

Body Mass Index (x)	Ages of respondents (y)	Female	Male
< 18	18-29 years	5	14
	30-39 years	2	1
	$\geq$ 40 years	2	-
18 –<25	18-29 years	45	44
	30-39 years	36	8
	$\geq$ 40 years	38	24
$\geq$ 25	18-29 years	3	3
	30-39 years	8	5
	$\geq$ 40 years	15	1

II. METHODOLOGY:

The Body Mass Index (x) with mean μ and variance Σ_{xx} were investigated for possible relationship with Ages of respondent (y) with parameters $\mu = 0$ and variance Σ_{yy} using a bivariate logistic distribution with covariance Σ_{xy}. The bivariate logistic distribution is given as

$$f(x,y) = \frac{\exp\left\langle \left(-\begin{bmatrix} x-\mu \\ y \end{bmatrix}^T \begin{bmatrix} \Sigma_{xx} & \Sigma_{xy} \\ \Sigma_{xy} & \Sigma_{yy} \end{bmatrix}^{-1} \begin{bmatrix} x-\mu \\ y \end{bmatrix} \right)^{\frac{1}{2}} \right\rangle}{\left| \begin{bmatrix} \Sigma_{xx} & \Sigma_{xy} \\ \Sigma_{xy} & \Sigma_{yy} \end{bmatrix}^{\frac{1}{2}} \right| \left[1 + \exp\left\langle \left(-\begin{bmatrix} x-\mu \\ y \end{bmatrix}^T \begin{bmatrix} \Sigma_{xx} & \Sigma_{xy} \\ \Sigma_{xy} & \Sigma_{yy} \end{bmatrix}^{-1} \begin{bmatrix} x-\mu \\ y \end{bmatrix} \right)^{\frac{1}{2}} \right\rangle \right]^2} \quad (1)$$

III. RESULTS:

The data analysis using R software reveals the following statistics

Females: $\bar{x}$ =22.08509, $\bar{y}$ = 35.55844, Σ_{xx} =10.26707, Σ_{yy} =120.20898 Σ_{xy} =11.04014

Males: $\bar{x}$ = 20.96080, $\bar{y}$ = 30.46000, Σ_{xx} = 11.487098, Σ_{yy} =179.543838, Σ_{xy} =8.445083

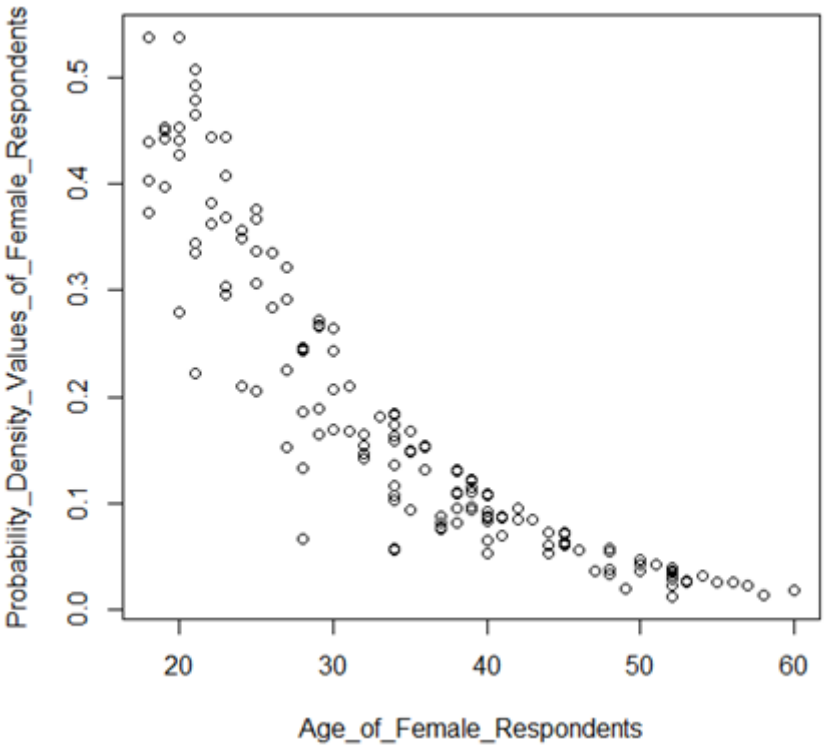

Figure 1. Graph of the Female respondents body mass index density values against their respective ages

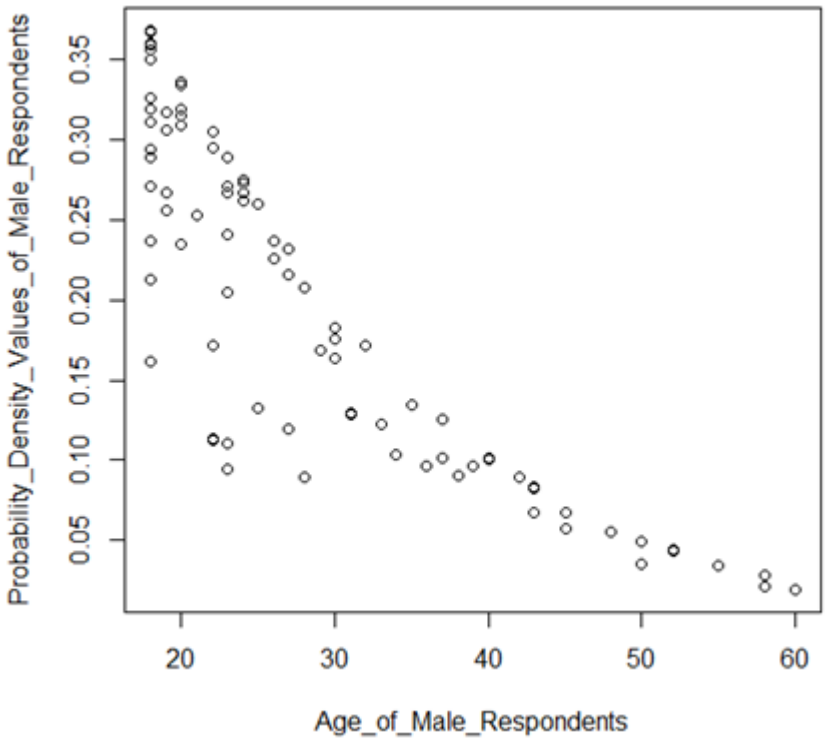

Figure 2. Graph of the Male respondents body mass index density values against their respective ages

Both figure 1 and figure 2 reveals that changes in the body mass index could be observed in both the male and the female respondents. Only that the ages at which the value becomes high and could be catastrophic if not monitored deffered between gender.

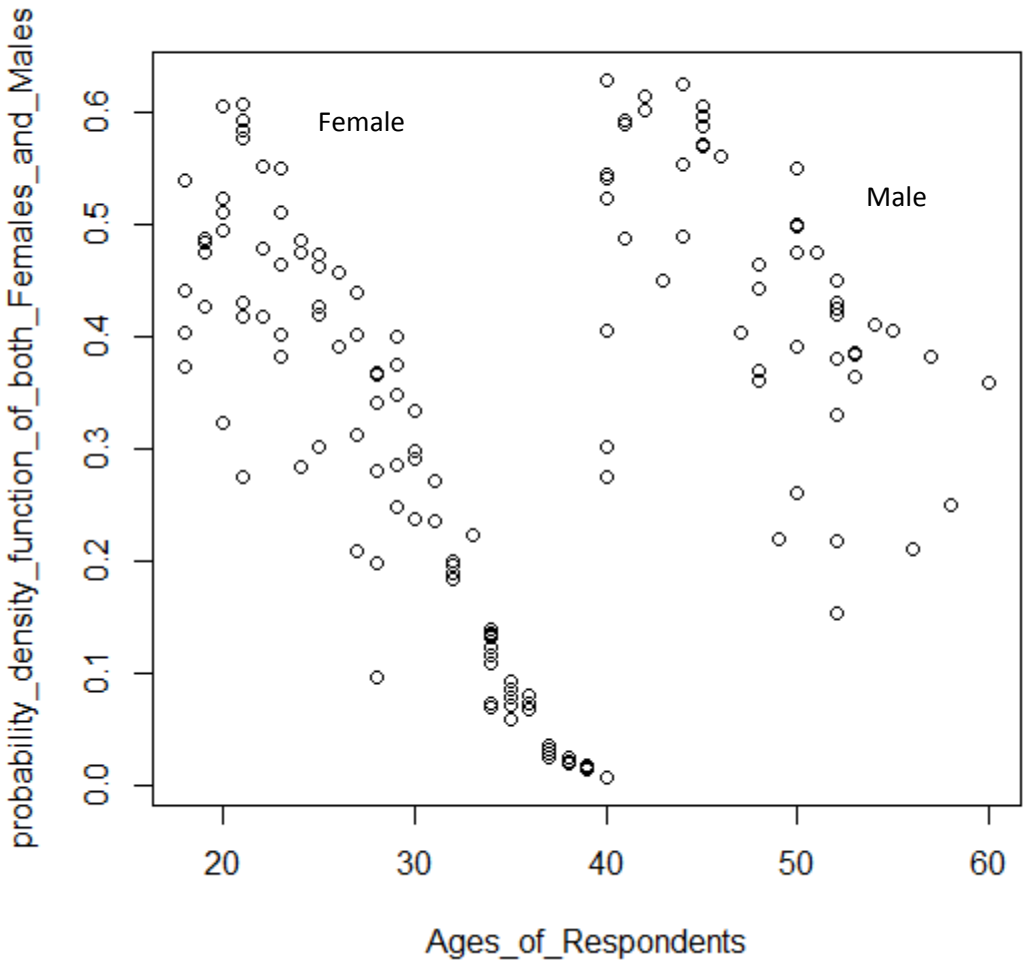

Figure 3. Graph of the Female and Male respondents body mass index density values against their respective ages

Investigating the ages at which the respondents are likely prone to abnormal BMI, we plot the graph of probability density function values of male and female BMI against specific ages (figure 3). From the graph, high Body Mass index for Female and Males with respects to their ages at regular intervals reveals that women are significantly prone in the age range of 20 years to 40 years with density value decline rate ranging from 0.6 at 20 years of age to as low as 0.01 when the individual is ageing beyond 40 years while that of the males become pronounced from 40 years towards 50 years and begins to show a decline as the male counterpart grows older beyond 50 years of age. The probability density function decline rate of the body mass index of the males was however between the range > 0.6 to 0.15.

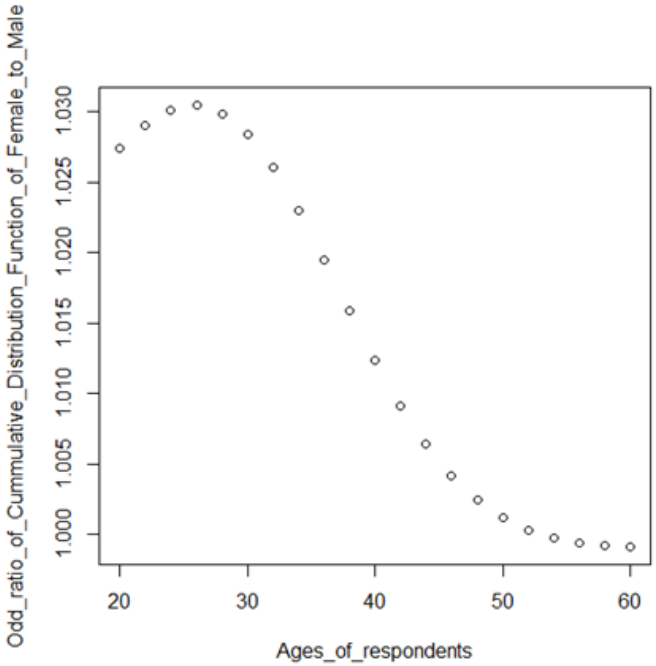

Figure 4. Graph of the odd-ratio of Female to Male respondents body mass index cumulative distribution function values against their respective ages

Figure 4 investigate the odd ratio of high body mass index due to build up of fat in the body between female and male respondents as their age increases. The study shows that the odds of high body mass index by females is slightly higher than that of their male counterpart from the ages of 20years to 40 years with its peak between 27 years and 32 years of age; this however begins to drop until the odds of body mass index ratio between female and male becomes equal at the age of 50 years. Beyond the age of 50 years, the study shows a decline in the odds of high body mass index irrespective of gender.

IV. CONCLUSION:

The staff and student of the University of Port Harcourt have a well-controlled body mass index. This may be due to students' everyday activities that make them to burn their fat and also due to the awareness of avoiding food that promotes fat in the body. However the study reveals a risk tendency of having cardiovascular issues if no proper monitoring is done for females within the age of 20 years and 40 years due to high body mass index. Knowing well that this age interval includes the productive ages of the female folks, and as they reproduce they are likely to gather fat, it is important for them to monitor their BMI within this interval as well as avoid stress that could trigger any form of cardiovascular issues. Similarly, the male folks are prone to high body mass index in the early 40's which maintained a high density level as the person moves beyond 55 years before it begin to show some decline as the person age increases from 55 years toward 60 years. So male folks should be mindful of the stress they engage in within this age interval, since at that time, they are likely to have settled down marital wise and as such build up body fats due to regular sweet food intake.

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