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MODELING VITAL SIGNS COMPONENTS AND IT CONSEQUENCE IN HUMAN HEALTH

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ABSTRACT

Vital sign component in human life is very significant for healthy growth. The main objective of this research work is to determine the relationship between vital sign component and its consequence as well as to demonstrate the use of statistical methods in medicine to figure out the efficiency of the model. The result reveals that logistic and inverse models perform better than other models under the studies and that pulse response and age are vital signs components in human health.

INTRODUCTION

Vital signs often shorten to just vitals are the evidence of the current physical functioning of the body. They provide critical information that is 'vital' for life and so they are called vital signs (NEWSDIG 2012). These measurements are taken to help assess the general physical health of a person, give clues to possible diseases, and show progress toward recovery. The normal ranges for person vital signs vary with age, weight, gender and overall health. There are four primary vital signs body temperature, blood pressure, pulse (heart rate) and breathing rate (respiratory rate). Normal vital sign ranges for the average healthy adult while resting is: (i) Blood pressure: 90/60 mm/Hg to 120/80 mm/Hg (ii) Breathing: 12-18 breaths per minute

(iii) Pulse: 60-100 beats per minute (iv)Temperature: 97.8-99.1 degrees Fahrenheit / average 98.6 degrees Fahrenheit.

Vital signs are assessed at least every 4 hours in hospitalized patients with elevated temperatures, with low or high blood pressures, with change in pulse rate or rhythm or with respiratory difficulty as well as in patients who are taking medications that effect cardiovascular or respiratory function or had a surgery. A change in vital signs may indicate a change in health (Mower W, Barraf L 1997). Vital sign monitoring plays an important role in human life by knowing the change that has occurred in the body system but most people are still ignorant about their health status which lead to complication of health and even result to unexpected death in most cases. Upon how important it is to know patient vital signs before administering any treatment or medication some health practitioners still worsen most cases by not showing proper care to their patient and most instrument used in determining patient vital signs are extremely outdated. The broad aim of this study is to apply statistical tool to the four components of vital sign of patient in order to examine the trend of those signs.

The objectives are to determine the relationship between the vital signs (age, weight, blood pressure and pulse rate) of a patient. To test for efficiency of the model to fit appropriate trend equation to each vital sign to figure out the best model for each variation on the basis of adjusted R^2, P-value and percentage of significant parameters. The importance of this research work is to establish the statistical models for predicting the relationship between some vital signs component and providing recommendation that will enhance a reliable health status of a patient. This research focuses on vital signs (age, weight, blood pressure and pulse rate) of patient using Regression Analysis and the data used is extracted from the health register of General Hospital Offa, Kwara State.

LITERATURE REVIEW

As people age, they get plaque buildup inside the blood vessels, and the flexible walls of the arteries become stiff. (Thomas, F. Bean, k. Pannier, 2005). The first vital sign done by the nurse, in the emergency situation, would be to see if the person has a heartbeat. The nurse wants to know if the person's heart is beating and at what rate. Next the nurse will check for the person's respirations and get a blood pressure cuff to check the blood pressure. The last vital sign is temperature. But this is not as important as the first three vital sign (Macmahon. S. Cutler. J. Brittain. E. Higgina. M.1957). Blood pressure is one of the vital signs that doctors measure to assess general health. About one in three U.S adults have high blood pressure and only about half of these people have their high blood pressure under control, according to the central of disease control and prevention (CDC). High blood pressure is some-times referred to as the "silent killer" because it often has no symptoms. Roughly 1 billion individuals worldwide are estimated to exhibit clinically significant elevated blood pressure with about 50 million of those residing in the United States. (Havas S, Roccella EJ, Lenfant C. 2004). Hypertension, in turn, is associated with increased risk for cardiovascular disease (CVD), stroke, renal disease, and all-cause mortality. Obesity and hypertension are both major public health problem in western society. Results from the Framingham study have shown that high blood pressure and overweight are both independent risk factors for cardiovascular disease. Hypertension is one of the most common obesity-related complications and about 30% of hypertensive individuals can be classified as being obese in a group of hypertensive women taken from the Nurses' Health Study.

A laboratory report was review when investigating the relationships between variables such as age, weight, height, level of physical activity, gender and diet and how these contribute to the cardiovascular risk in the development of hypertension. And their outcome is that age is also a critical factor when it comes to the risk of developing hypertension and other cardiovascular diseases. A cross – sectional observational study by (Neves 2011) determined that overweight and obesity were related to higher cardiovascular risk. The object who were overweight or obese had a lower mean HDL cholesterol, higher triglycerides, higher fasting glucose and more frequent mild valve disease. This factor can also increase the chances of getting diabetes and hyper cholesterol. Reducing fat and excess weight may have a significant impact on the development of risk factor.

It is very important to examine vital signs and determine the relationship between the vital signs variables on patient using statistical methodology.

REVIEW OF STATISTICAL MODEL

The statistical analysis applied in this study is regression analysis. This method is reviewed as described in Guptal, et al (1992) and Spiegel (2008). The regression analysis is the commonest statistical method of forecasting; it indicates the nature of relationship or the nature of influence among variables. The study of regression analysis was introduced by Francis Galton a statistician who proposed the Galton law of universal regression in 1856 and it was confirmed by Karl Pearson in 1903. In statistics, regression analysis is the statistical process for estimating the relationship among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variable (or 'predictors'). It particularly useful for modeling behavior of variables in respect to finding the best relationship between the variable and other variable known as independent variables.

Linear regression analysis is a powerful technique used for predicting the unknown value of a variable from the known value of another variable. (Cook and Clerk 1982), linear regression analysis helps us to predict the value of Y for a given value of X. By linear regression, we mean models with just one independent and one dependent variable. The variable whose value is to be predicted is known as the dependent variable and the one whose known value is used for prediction is known as the independent variables.

METHODOLOGY

The collection of adequate and reliable information/data is a very important aspect in using statistical procedure to analyze a specific problem; before any statistical work can be done at all a relevant data must be collected. Therefore, data plays an important role to increase the reliability of the research work. Most statistical analysis and inference are conducted with data collected from primary source, secondary source or both. In this research work, the data used is strictly from secondary source i.e. already existing in the diagnosis record of General hospital Offa, Kwara state.

The method of data analysis used in this research work is REGRESSION ANALYSIS and some TREND MODELS which includes (inverse, cubic, growth, exponential and logistic) model were used to analyze the data on statistical package for social sciences (SPSS) from which model selection was made based on the adjusted R^2, P-value and percentage of significant parameter of each model. The model with the smallest significant p-vale and at the same time has the highest percentage of significant parameter is selected to best explain the variable.

Assumption of Linearity

Linear regression does not test whether data is linear. It finds the slope and intercepts assuming that the relationship between the independent and dependent variable can be best explained by a straight line. One can construct the scatter plot to confirm this assumption. If the scatter plot reveals nonlinear relationship, often a suitable transformation can be used to attain linearity.

Proposes that there is a straight/linear relationship between variables and uses the relationship to predict the value of others but when only one independent variable is involved it is called simple linear regression. The independent variable is denoted by Xi.

The simple linear equation is given by $Y_i = \hat{b}_0 + \hat{b}_i X_i + e$

Where

$\hat{b}_0$, bi are the intercept and slope respectively and

e is the error term.

But if the variable involved is more than one independent variable it is then called multiple regressions. A multiple regression is functional if the relationship of dependent variable to k independent variables $X_1, X_2 ... X_k$ expressed as:

$$Y = +b_0 X_0 + b_1 X_1 + b_2 X_2 + ... b_k X_k + u$$

Where E (μ) = 0

Testing for Efficiency of the Model

In order to test the significance of parameter estimate we apply the t-statistic, where we follow the same procedure as we employed in the simple regression model

After obtaining parameter estimates, b_o, b_i,…., b_k. It is usually of interest to test for their significance. The two-tail test given below can be utilized to achieve this.

Hypothesis

Ho: $b_1 = 0$

H1: $b_1 \neq 0$

Test statistic $t_c = \frac{b_0}{\sqrt{(b)}}$

Decision rule: Reject Ho if $| t_c| > t\alpha/2$ at $\alpha = 0.05$ otherwise do not reject Ho.

The overall significance of regression can be tested with the ratio of the explained to be unexplained variance. This test is aimed at finding out whether the explanatory variables (x_1, x_2,…, x_k) do actually have significant influence on the dependent variable. The procedure is therefore condensed into ANOVA table below.

Source of variance	Degree of freedom	Sum of squares	Mean square	f-ratio
Regression (Explained) Residual/Error (Unexplained)	K – 1 N – K	SSR SSE	$\frac{\sum Y^2}{k-1}$ $\frac{\sum e^2}{N-K}$	$\frac{\sum Y^2 / K-1}{\sum e^2 / N-K}$
Total	N – 1	SST		

The Coefficient of Multiple Determinations

The coefficient of multiple determination is denoted by R^2 or r^2 and pronounced R square is a number that indicate how well data fit a statistical model, sometimes simply a line or statistical models whose main purpose is either the prediction of future outcomes or the testing of hypothesis on the basis of other related information. It provides a measure of how well observed outcomes are replicated by the model as the proportion of total variation of outcomes explained by the model.

$$R^2 = \frac{\sum \hat{b}_1 x_1 y}{\sum y^2} = \frac{b_1 \sum x_1 y + b_2 \sum x_2 y + b_k \sum x_k y}{\sum y^2}$$

Where

The value of R^2lies between 0 and 1, the higher R^2 the greater the percentage of variation of y explained by the regression plane, that is the better the goodness of fit of the regression plane to the sample observations.

The independent variable will usually raise the value of R^2 since the numerator is increased while the denominator remains the same. To correct for the adjusted coefficient of determination (R^2) and is defines as below $R^2 = 1-(1-R^2)\left[{n-1}/{n-k}\right]$

Trend Model

Different linear and non-linear models are studied for the purpose of estimating the component of vital signs and fitting appropriate trend equation to each of the signs and to select the best model for each of the variables on the basis of the adjusted R^2, p-value and percentage of significant parameters. Models with the smallest p-value and at the same time having the highest percentage of significant parameters will be adopted as the best regressed model capable of better explaining the historical trend and producing useful future predictions.

The curve estimation procedure produces curve estimate on regression statistics between two variables having series regression estimate curve model which includes (Inverse, Cubic, Growth, Logistic and Exponential) etc. And the model is mathematically represented as follows:

- Inverse model: $Y = \frac{bo+b1}{t}$
- Cubic model: $Y = b_0 + b_1 t + b_2 t^2$
- Growth model: $Y = e^{b0+b1t}$
- Logistics model: $Y = \left(\frac{1}{u} + b_0 b_1 t\right) - 1$
- Exponential model: $Y = b_0 e^{b1t}$ .etc.

  Where

  bo = constant

  bn = Regression coefficient

  t = Independent variable or time value

  ln = The natural logarithm

u = Upper bound value for logistic.

While

The non-linear models are the power model, S-model compound model and Growth model etc.

RESULT AND DISCUSSION

The models used to check whether the components were able to reveal the significant relationship amongst the vital signs (Age, Weight with Blood Pressure)

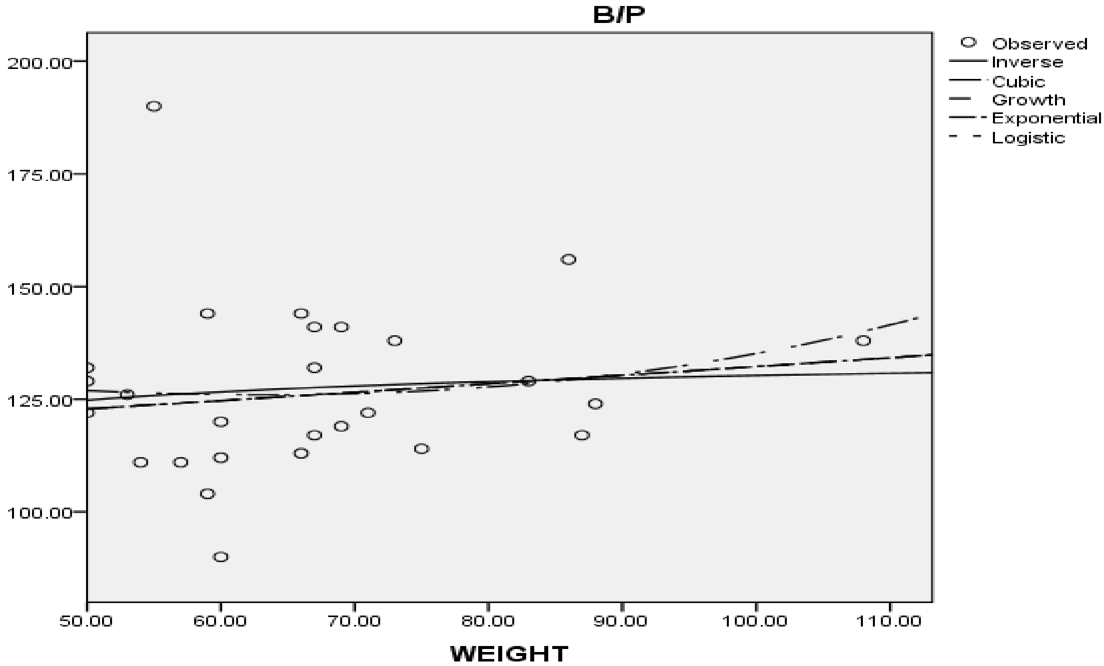

Figure 1 present the models and the relationship associated with Blood pressure and Weight of individuals

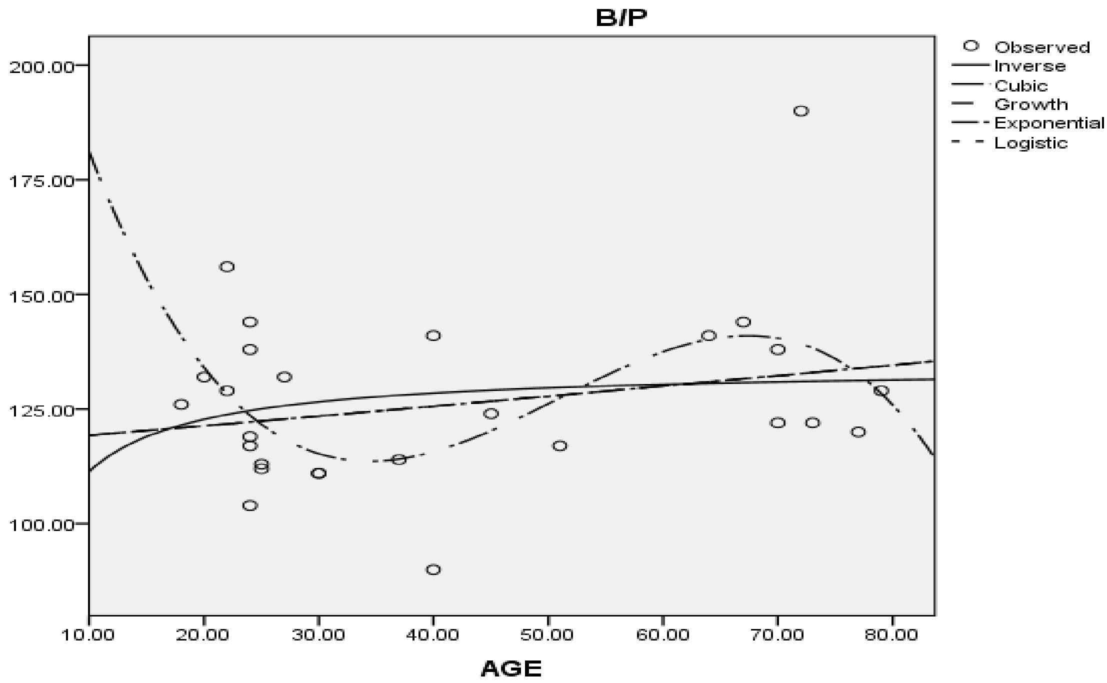

Figure 2 present the models and the relationship associated with Blood pressure and Age of individuals

PULSE RATE

Logistic

Coefficients

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
AGE	1.002	.002	1.216	660.736	.000
(Constant)	.012	.001		14.181	.000

The dependent variable is ln(1 / PR).

Exponential

Coefficients

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
WEIGHT	.005	.002	.444	2.480	.020
(Constant)	53.862	7.817		6.890	.000

The dependent variable is ln(PR).

Coefficients

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 / WEIGHT	-2064.986	780.850	-.468	-2.645	.014
(Constant)	109.598	12.286		8.921	.000

Since p-value are 0.014 and 0.000, we therefore conclude that the parameters are significant at $\alpha = 0.05$ level of significance.

Coefficients

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
AGE	.998	.001	.774	769.594	.000
(Constant)	.009	.001		16.517	.000

The dependent variable is ln(1/B/P). since the p-value are 0.000 and 0.000 we therefore conclude that the parameters are significant at $\alpha = 0.05$ level of significance.

CONCLUSION

Logistic and Exponential models are the best models that can yield a better result, since the p-value are 0.000 and 0.000 for logistic model and 0.020 and 0.000 for exponential model respectively. we therefore conclude that the parameters (Pulse response, weight, age and blood pressure) are significant at $\alpha = 0.05$ level of significance. Base on this research work it shows that there is an association between some component of vital signs and people should therefore monitor their vital signs in order to keep fit. The following statistical tools, logistic and exponential model is recommended in medicine to measure association of vital signs in patient.

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