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Application of Cramer's Rule and Digital Computing in Analyzing Multiple Linear Regression

[*1]Nwaigwe, E., & [2]Wobo, O. G.
[1,2]Department of Statistics, Captain Elechi Amadi Polytechnic, Port Harcourt, Nigeria

***Corresponding author email:** echendunwaigwe@yahoo.com

Abstract
This paper examined a multiple linear regression model $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2$.The model is a relationship between a dependent variable, body mass (y) and two independent variables, age (x_1) and height (x_2). Multivariate data in terms of y, x_1, and x_2 were generated from fifteen first-year students running National Diploma (ND) programme in Department of Computer Engineering, Captain Elechi Amadi Polytechnic, Rumuola, Port Harcourt. The data were used to digitally compute β_0, β_1 and β_2 of the model through the application of Cramer's rule and the results were validated by SPSS output. Sampled data were also used to compute the Body Mass Index (BMI) of the students to determine whether they were underweight, normal weight, overweight or obese. Additionally, the sampled data values of x_1 and x_2 were used to estimate y using the already computed values β_0, β_1 and β_2. The results of the study showed that values obtained from Cramer's rule (use of MATLAB 45.0) for β_0, β_1 and β_2 were consistent with SPSS output. Also, computed results $\beta_0 = 19.0721$, $\beta_1 = 0.3544$ and $\beta_2 = 18.8728$ indicated that height (x_2) was a greater predictor of body mass (y) than age (x_1). Further, students' BMI results revealed that out of the fifteen students sampled, thirteen were of normal weight while two were overweight. It was concluded that: Cramer's rule is a reliable method of analyzing multiple linear regression models since its results were consistent with SPSS output; although overweight is not an illness, it may be a potential symptom of health risk. Therefore, it was recommended that individuals regularly know their BMI, engage in physical exercise and stay on diets that do not promote overweight to avoid health risks.

Keywords: Cramer's Rule**,** Multiple Linear Regression, Dependent Variable, Explanatory Variable, Body Mass Index.

Introduction

Linear regression analysis is a statistical technique used for modelling and investigating linear relationships between one or more independent variables and a single dependent variable of interest (Douglas et al., 2012). If the model has a single independent variable that has a relationship with a response variable y, it is known as simple linear regression. On the other hand, if there are two or more independent variables, it is called multiple linear regression or multilinear regression. The focus of this study is on multiple linear regression analysis. It is a statistical technique that seeks to establish a mathematical model that describes the relationship between a dependent variable and two or more explanatory variables (independent variables). It examines how multiple independent variables are related to one dependent variable. In other words, it considers the effect of more than one independent variable on an outcome of interest. Multiple linear regression evaluates the relative effect of independent variables on a dependent variable when all other variables in the model are held constant. Once each of the independent factors has been determined to predict the dependent variable, the information about the multiple variables can be used to establish an accurate prediction on the level of effect they have on the outcome variable. Multiple linear regression analysis does not permit us to make causal inferences, rather it allows us to investigate how a set of explanatory variables is associated with a response variable of interest.

The multiple linear regression model establishes a relationship in the form of a straight line (linear) that best approximates all the individual data points. The straight line which is also known as the line of best fit minimizes the variances of each of the independent variables included in the model as it relates to the dependent variable. Because the regression model fits a line, it is a linear model.

Cramer's rule also known as the determinant method is one of the mathematical methods used to solve a system of linear equations in n variables and n equations. This rule is named after a Swiss mathematician Gabriel Cramer (1704 – 1752) who published the rule for an arbitrary number of variables in 1750. In Cramer's rule, the value of the variable is calculated in terms of determinants of the coefficient matrix and matrices obtained from it by replacing one column with the column matrix of the constant matrix in the equation. For instance, if we have a system of linear equations with n variables $x_1, x_2, x_3, \dots x_n$ written in matrix form $AX = B$ where A is the coefficient matrix (square matrix), X is the matrix of the variables and B is the constant matrix. Now, we have to find the determinants $|D| = |A|$, $|Dx_1|, |Dx_2|, |Dx_3|, \dots, |Dx_n|$. Here $|Dx_i|$ for $i = 1,2,3, \dots, n$ is the same determinant as $|D|$ only that one of the columns of $|D|$ is replaced with B to obtain $|Dx_i|$. If $|A| \neq 0$, the system of equations is consistent and independent and has a unique solution for $X = x_1, x_2, x_3, \dots x_n$. Thus, we obtain X as: $x_1 = \frac{|Dx_1|}{|D|}$, $x_2 = \frac{|Dx_2|}{|D|}$, $x_3 = \frac{|Dx_3|}{|D|}$,…, $x_n = \frac{|Dx_n|}{|D|}$. If $|A| = 0$, Cramer's rule does not provide a solution.

However, several studies have been conducted on multiple linear regression. For instance, Li and Fan (2023), used a multiple regression analysis model to investigate the factors affecting the learning effect of hybrid teaching based on a superstar platform of four years of application of Excel in a course in finance. SPSS software was used to analyze the data obtained from the superstar platform and another platform described as students' offline learning from 2019 to 2022 of the course "Application of Excel in Finance." The results of the study showed that online homework completion has the greatest impact, followed by offline assessment and then video viewing. Kanyongo and Launcelot (2006), used regression analysis to investigate the relationship between home environment and reading achievement among Grade 6 students in Zimbabwe. Data used for the study was collected by the Southern and Eastern African Consortium for Monitoring Educational Quality (SACMEQ). The data were subjected to linear regression analysis through structured equation modelling using AMOS 4.0. The results of the study revealed that a proxy for Socio-Economic Status (SES) was the strongest predictor of reading achievement.

Samson et al (2000), studied the relationship between physical performance measures like age, height, and body mass in healthy adults. In the study, the authors measured muscle strength and functional mobility in healthy men and women over the adult age range and used the information to investigate the changes with age and sex and to establish the effects of anthropometric indices of height and weight. The results of the study indicated that older subjects had lower values for muscle strength and muscle power than young subjects. It was found that muscle strength and functional mobility decline with age in healthy people. Also, it was found that in women, there was an accelerated reduction in muscle strength above the age of 55. The authors concluded that lower values in healthy old subjects were partly associated with differences in height and body weight.

Gerald and David (2022), investigated students' body weight and categorized it into a grid as to whether they are underweight, normal body weight, obese or extremely obese. The study was conducted with a total of 208 year one students (97 male and 111 females) of Physical Education University, Zambezi region of Namibia. The data used for the study were gathered with the "student BMI calculation form" bathroom scale with 0.1 sensitivity and a static vertical measuring tape. The results showed that 61(29.3%) of the students were found to have normal body weight, 26(12.5%) were underweight, 106(51%) were overweight and 15(7.2%) were found to be obese. It was also found that the frequency of being underweight, overweight and obese indicated higher scores in female participants compared to that of males. Despite female dominance in 3 BMI grids, male participants scored 41% higher under normal body weight than females who scored 21%. It was concluded that overweight and obese results found in all genders were a severe risk to health.

Jarrett et al. (2010) carried out a cross-sectional study on the influence of body mass index, age and gender on the current illness of persons taking medication and the total number of medications taken by them. To determine the relationship between body mass index, age and current health status, the authors weighted the data from the 1988 – 1994, 2003 – 2004 and 2005 – 2006 National Health and Nutrition Examination Surveys to represent the United States population. BMI, age, gender and current medication used were analyzed in a sample – adjusted figure of 9071 women and 8880 men. The results of the study showed that in both the 1988 – 1994 and 2003 – 2006 sets of data, with few exceptions, medication loads did not increase significantly in persons with overweight compared with those of normal weight. Medication loads increased significantly in obese compared with normal-weight persons aged 40+, but only marginally at 25 – 29 years. Also, it was found that medication loads were higher in women than men, but significantly less in persons aged 55 – 70.

Many people ask: How much should I weigh? The fact is that there is no single ideal weight for all individuals. Generally, the greatest body mass is found among individuals within the 50 – 59 years age group and declines gradually after one hits 60 years. In the mid –seventies, body mass tends to increase again, followed by a small drop off. Obviously, body mass varies as individuals grow from one stage to another in life. Variation in body mass may depend on factors such as height, age and body composition. While age and gender might alter the effect of body weight on physical health, obesity poses a significant health risk (Jarrett et al, 2010).

A common tool that measures a person's body mass in relation to their height is the Body Mass Index (BMI). The BMI does not measure an individual's body composition or their health. Rather, it is a screening tool that can be used alongside other tests and assessments to estimate the amount of body fat mass of an individual or to determine their potential health risks (Islam et al., 2017). According to the Centre for Disease Control and Prevention (CDC): A BMI of less than 18.5 suggests underweight; A BMI of between 18.5 and 24.9 suggests a healthy weight range; A BMI of between 25 and 29.9 may indicate overweight and a BMI of 30 or higher may indicate obesity. In developing countries, the prevalence of obesity has increased and worldwide over 1.1 billion adults are overweight and about 312 million are obese (Hossain et al., 2007). Numerous health complications are associated with obesity making obesity a risk factor for a number of diseases including hypertension, type 2 diabetes and cardiovascular disease. Obesity is also related to the metabolic syndrome a condition associated with an increased risk of death from all causes including cardiovascular disease (Pitner, 2005; Hu et al., 2004). Therefore, understanding the optimal body mass ranges for adults is crucial because such awareness is essential for maintaining overall personal health and preventing diseases related to weight and metabolism.

Undoubtedly, the literature reviewed above shows that there is a relationship between body mass, age and height. However, none of the referenced studies modelled body mass as a function of age and height. Based on this reason, the focus of this study is to formulate and analyze a multiple linear regression model that expresses body mass as a function of age and height to determine which of the variables age or height is a greater predictor of body mass. To achieve this aim, multivariate data has to be generated in terms of body mass, age and height and the model coefficients evaluated through the application of Cramer's rule computed using MATLAB a digital computing software and verified by SPSS output another digital computing software. It is against this background that this study is titled: Application of Cramer's rule and Digital Computing in analysis of Multiple Linear Regression.

Aim and Objectives

The aim of this study is to apply Cramer's rule and digital computing in multiple linear regression analysis. To achieve this aim, the following objectives guided the study:

1. To apply Cramer's rule (determinant method) to compute the coefficient (slope) of each explanatory variable of a multiple linear regression model using MATLAB 45.0;
2. To compute using Statistical Package for Social Sciences (SPSS) the coefficient of each explanatory variable of a multiple linear regression model;
3. To obtain a multiple linear regression model to predict body mass (y) given two explanatory variables – age (x_1) and height (x_2) and decide which of age (x_1) or height (x_2 is a greater predictor of body mass (y);
4. To predict body mass (y) given age (x_1) and height (x_2) and compare results with sample data.
5. To compute the body mass index of the research subjects.

Methods and Materials

In this section, we formulate the multiple linear regression model, state the assumptions that guided the model as well as present the procedure for the analysis of the model.

Model Formulation

Given **k** explanatory variables and **n** observations, the multiple linear regression model is of the form

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{\cdot i2} + \cdots + \beta_k x_{ik} + \epsilon_i \quad (1)$$

where: $i = 1,2,3,\ldots,n$ and

$y_i =$ dependent variable

$x_i =$ explanatory/independent variable

$\beta_0 =$ y – intercept (constant term)

$\beta_k =$ coefficient for each explanatory variable

$\epsilon_i =$ model's error term (residual)

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Model Assumptions

The above model (1) is guided by the following assumptions.

1. There is a linear relationship between the dependent variable and the explanatory variables.
2. The dependent variable is continuous and the explanatory variables are either continuous, binary or categorical.
3. y_i observations are selected independently and randomly from the population.
4. The explanatory variables are not too highly correlated with each other.
5. The residuals are normally distributed with mean 0 and variance equal to 1.
6. There is no more than limited collinearity.
7. Errors are independent.
8. There are no external variables (variables that are not included in the model) that have strong relationship with the dependent variable after controlling for the variables that are in the model.

Model Analysis

From equation (1), we generate other equations which are used to obtain the coefficients $\beta_0, \beta_1, \beta_2,\ldots, \beta_k$ respectively of the model.

By multiplying equation (1) by Σ, we have

$$\Sigma y = n\beta_0 + \beta_1\Sigma x_1 + \beta_2\Sigma x_2 + \cdots + \beta_k\Sigma x_k \tag{2}$$

Also, multiplying equation (1) by Σx_1, we have

$$\Sigma x_1 y = \beta_0\Sigma x_1 + \beta_1\Sigma x_1^2 + \beta_2\Sigma x_1 x_2 + \cdots + \beta_k\Sigma x_1 x_k \tag{3}$$

Similarly, multiplying equation (1) by Σx_2, we have

$$\Sigma x_2 y = \beta_0\Sigma x_2 + \beta_1\Sigma x_1 x_2 + \beta_2\Sigma x_2^2 + \cdots + \beta_k\Sigma x_2 x_k \tag{4}$$

Equations (2), (3) and (4) can be solved using Cramer’s rule. The Cramer’s rule is an application of determinant in solving a system of linear equations of the form

$$\begin{array}{l} a_{11}x_1 + a_{12}x_1 + a_{13}x_3 + \cdots + a_{1n}x_n = k_1 \\ a_{21}x_1 + a_{22}x_1 + a_{23}x_3 + \cdots + a_{2n}x_n = k_2 \\ \quad\vdots \qquad\quad \vdots \qquad\quad \vdots \qquad\qquad\quad \vdots \qquad \vdots \\ a_{n1}x_1 + a_{n2}x_1 + a_{n3}x_3 + \cdots + a_{nn}x_n = k_n \end{array} \tag{5}$$

.where $a_{11}, a_{12}, a_{13},\ldots, a_{nn}$ are the coefficients of $x_1, x_2, x_3,\ldots, x_n$ and $k_1, k_2, k_3,\ldots, k_n$ are constants.

Since we are to estimate body mass(y) using two explanatory variables – age (x_1) and height (x_2), then equations (2), (3) and (4) respectively become

$$n\beta_0 + \beta_1\Sigma x_1 + \beta_2\Sigma x_2 = \Sigma y \tag{6}$$

$$\beta_0\Sigma x_1 + \beta_1\Sigma x_1^2 + \beta_2\Sigma x_1 x_2 = \Sigma x_1 y \tag{7}$$

$$\beta_0\Sigma x_2\beta_1\Sigma x_1 x_2. + \beta_2\Sigma x_2^2 = \Sigma x_2 y \tag{8}$$

Equations (6), (7) and (8) are similar to the system of equations (5) and can be written in matrix form as

$$\begin{pmatrix} n & \Sigma x_1 & \Sigma x_2 \\ \Sigma x_1 & \Sigma x_1^2 & \Sigma x_1\Sigma x_2 \\ \Sigma x_2 & \Sigma x_1\Sigma x_2 & \Sigma x_2^2 \end{pmatrix} \begin{pmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{pmatrix} = \begin{pmatrix} \Sigma y \\ \Sigma x_1 y \\ \Sigma x_2 y \end{pmatrix} \tag{9}$$

Solving equation (9) using Cramer’s rule (determinant method), we have

$$\beta_0 = \frac{\begin{vmatrix} \Sigma y & \Sigma x_1 & \Sigma x_2 \\ \Sigma x_1 y & \Sigma x_1^2 & \Sigma x_1\Sigma x_2 \\ \Sigma x_2 y & \Sigma x_1\Sigma x_2 & \Sigma x_2^2 \end{vmatrix}}{\begin{vmatrix} n & \Sigma x_1 & \Sigma x_2 \\ \Sigma x_1 & \Sigma x_1^2 & \Sigma x_1\Sigma x_2 \\ \Sigma x_2 & \Sigma x_1\Sigma x_2 & \Sigma x_2^2 \end{vmatrix}} \tag{10}$$

$$\beta_1 = \frac{\begin{vmatrix} n & .\Sigma y & \Sigma x_2 \\ \Sigma x_1 & \Sigma x_1 y & \Sigma x_1 \Sigma x_2 \\ \Sigma x_2 & \Sigma x_2 y & \Sigma x_2^2 \end{vmatrix}}{\begin{vmatrix} n & \Sigma x_1 & \Sigma x_2 \\ \Sigma x_1 & \Sigma x_1^2 & \Sigma x_1 \Sigma x_2 \\ \Sigma x_2 & \Sigma x_1 \Sigma x_2 & \Sigma x_2^2 \end{vmatrix}} \quad (11)$$

.

$$\beta_2 = \frac{\begin{vmatrix} n & \Sigma x_1 & \Sigma y \\ \Sigma x_1 & \Sigma x_1^2 & \Sigma x_1 y \\ \Sigma x_2 & \Sigma x_1 \Sigma x_2 & \Sigma x_2 y \end{vmatrix}}{\begin{vmatrix} n & \Sigma x_1 & \Sigma x_2 \\ \Sigma x_1 & \Sigma x_1^2 & \Sigma x_1 \Sigma x_2 \\ \Sigma x_2 & \Sigma x_1 \Sigma x_2 & \Sigma x_2^2 \end{vmatrix}} \quad (12)$$

Substituting the values of β_0, β_1 and β_2 into equation (1), we obtain the following regression equation.

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \quad (13)$$

Equation (13) can be used to predict body mass (y) given any individual's age (x_1) and height (x_2).

Results

The data presented below shows the age (x_1) in years, height (x_2) in metres (m) and body mass (y) in kilogramme (kg), obtained from 15 ND1 students of the Department of Computer Engineering, Captain Elechi Amadi Polytechnic, Rumuola, Port Harcourt.

Table 1: Data showing age (x_1) in years, height (x_2) in metres (m) and body mass (y) in kilogramme (kg) of 15 ND1 students of the Department of Computer Engineering, Captain Elechi Amadi Polytechnic, Rumuola, Port Harcourt.

S/No	Age (yrs) x_1	Height (m) x_2	Body Mass (kg) y	x_1^2	x_2^2	x_1y	x_2y	x_1x_2	BMI $= \frac{y}{x_2^2}$
1.	22.4	1.6	57.3	501.76	2.56	1,283.52	91.68	35.84	22.38
2.	26.2	1.7	60.1	686.44	2.89	1,574.62	102.17	44.54	20.80
3.	25.0	1.5	56.5	625.00	2.25	1,412.50	84.75	37.50	25.11
4.	27.6	1.8	62.7	761.76	3.24	1,730.52	112.86	49.68	19.35
5.	23.7	1.5	55.2	561.69	2.25	1,308.24	82.80	35.55	24.53
6.	22.9	1.6	57.8	524.41	2.56	1,323.62	92.48	36.64	22.59
7.	29.4	1.7	62.3	864.36	2.89	1,831.62	105.91	49.98	21.56
8.	26.3	1.6	57.4	691.69	2.56	1,509.62	91.84	42.08	22.42
9.	24.0	1.6	58.9	576.00	2.56	1,413.60	94.24	38.40	23.01
10.	21.5	1.5	56.4	462.25	2.25	1,212.60	84.60	32.25	25.072
11.	27.1	1.7	61.2	734.41	2.89	1,658.52	104.04	46.07	1.18
12.	20.6	1.6	54.9	424.36	2.56	1,130.94	87.84	32.96	21.45
13.	22.3	1.5	55.6	497.29	2.25	1,239.88	83.40	33.45	24.71
14.	21.8	1.7	59.7	475.24	2.89	1,301.46	101.49	37.06	20.66
15.	24.6	1.6	56.3	605.16	2.56	1,384.98	90.08	39.36	21.99
.	872.3	365.4	24.2	8,991.82	39.16	21,316.24	1,410.18	591.36	

By substituting the values from Table 1 into equations (10), (11) and (12), and using MATLAB to evaluate the determinants we have

$$\beta_0 = \frac{\begin{vmatrix} 872.3 & 365.4 & 24.2 \\ 21,316.24 & 8,991.82 & 591.36 \\ 1,410.18 & 591.36 & 39.16 \end{vmatrix}}{\begin{vmatrix} 15 & 365.4 & 24.2 \\ 365.4 & 8,991.82 & 591.36 \\ 24.2 & 591.36 & 39.16 \end{vmatrix}} = \frac{2,066.7152}{108.3632} = 19.0721$$

$$\beta_1 = \frac{\begin{vmatrix} 15 & .82.3 & 24.2 \\ 365.4 & 21,316.24 & 591.36 \\ 24.2 & 1,410.18 & 39.16 \end{vmatrix}}{\begin{vmatrix} 15 & 365.4 & 24.2 \\ 365.4 & 8,991.82 & 591.36 \\ 24.2 & 591.36 & 39.16 \end{vmatrix}} = \frac{38.4032}{108.3632} = 0.3544$$

$$\beta_2 = \frac{\begin{vmatrix} 15 & 365.4 & 872.3 \\ 365.4 & 8,991.82 & 21,316.24 \\ 24.2 & 591.36 & 1,410.18 \end{vmatrix}}{\begin{vmatrix} 15 & 365.4 & 24.2 \\ 365.4 & 8,991.82 & 591.36 \\ 24.2 & 591.36 & 39.16 \end{vmatrix}} = \frac{2,045.1224}{108.3632} = 18.8728$$

Table 2: SPSS output showing intercept (β_0), slope (β_1) of age and slope (β_2) of height

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% CI for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero order	Partial	Part
1	(Constant)	19.072	4.812		3.964	.002	8.589	29.556			
	Ages	.354	.130	.355	2.727	.018	.071	.638	.740	.619	.293
	Height	18.873	3.612	.680	5.224	.000	11.002	26.744	.881	.833	.560

a. Dependent Variable: Body mass (y)

It is obvious from the above results that the values of β_0, β_1 and β_2 are consistent with those of SPSS output in Table 2.

Substituting $\beta_0 = 19.0721$, $\beta_1 = 0.3544$ and $\beta_2 = 18.8728$ into equation (13), we have

$y = 19.0721 + 0.3544x_1 + 18.8728x_2$ ……………………………………………………(14)

Equation (14) is the multiple linear regression model required to estimate body mass (y_i) of each experimental subject given his/her age (x_{i1}) and height (x_{i2}).

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Table 3: Data showing estimated body mass (y_i) obtained from equation (14), given age (x_{i1}) and height (x_{i2}).

S/No.	Age (x_1)	Height (x_2)	Body mass (y)	Estimated Body mass (y_i)	Residuals/ Errors ($y_i - y$)	$(y_i - y)^2$
1.	22.4	1.6	57.3	57.21	- 0.09	0.0081
2.	26.2	1.7	60.1	60.44	0.34	0.1156
3.	25.0	1.5	56.5	56.24	- 0.26	0.0676
4.	27.6	1.8	62.7	62.82	0.12	0.0144
5.	23.7	1.5	55.2	55.78	0.58	0.3364
6.	22.9	1.6	57.8	57.38	- 0.42	0.1764
7.	29.4	1.7	62.3	61.58	- 0.72	0.5184
8.	26.3	1.6	57.4	58.59	1.19	1.4161
9.	24.0	1.6	58.9	57.77	- 1.13	1.2769
10.	21.5	1.5	56.4	55.00	- 1.40	1.9600
11.	27.1	1.7	61.2	60.76	- 0.44	0.1936
12.	20.6	1.6	54.9	56.57	1.67	2.7889
13.	22.3	1.5	55.6	55.28	- 0.32	0.1024
14.	21.8	1.7	59.7	58.88	- 0.82	0.6724
15.	24.6	1.6	56.3	57.99	1.69	2.8561
					-0.01	12.5033

We compute the mean (μ) and variance (δ^2) of the residuals as follows:

$$\mu = \frac{\sum(y_i - y)}{n} = \frac{-0.01}{15} = -0.001$$

$$\delta^2 = \frac{\sum(y_i - y)^2}{n} = \frac{12.5033}{15} = 0.8336$$

Discussion

Table 1 indicates that the BMI of sampled students is normal except for two students, serial numbers 3 and 10 who are overweight with BMI of 25.11 kg/m^2 and 25.07 kg/m^2 respectively. The result $\beta_0 = 19.0721$ means that when age (x_1) is zero and height (x_2) is zero as well, then body mass (y) would be $19.0721 kg/m^2$. The results $\beta_1 = 0.3544$ and $\beta_2 = 18.8728$ show that a unit change in age (x_1) brings about 0.3544 unit change in body mass (y) and a unit change in height (x_2) results in 18.8728 units change in body mass (y). Therefore, height (x_2) is a greater predictor of body mass (y) than age (x_1). Table 2, the SPSS results for intercept (β_0), slope (β_1) of age and slope (β_2) of height are consistent with results obtained using Cramer's rule. Table 3 shows that estimated body masses (y_i) compare favourably with original sample data values of body mass (y). Also, $\mu = -0.001$ and $\delta^2 = 0.8336$ computed from data in Table 3 show that the mean and variance of the residuals are approximately 0 and 1 respectively. These results confirm the assumption stated earlier that the residuals are normally distributed with mean $\mu = 0$ and variance $\delta^2 = 1$.

Conclusion

This study considered the application of Cramer's rule and digital computing in analyzing the multiple linear regression model $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2$. From multivariate data generated for the study, the constant term of the model β_0, and β_1 and β_2 the coefficients of x_1 and x_2 were computed with MATLAB through the application of Cramer's rule in order to predict body mass (y) given specific values of age (x_1) and height (x_2). The computed value $\beta_2 = 18.8728$ being greater than $\beta_1 = 0.3544$ means that height (x_2) is a greater predictor of body mass (y) than age (x_1). The constant of the model β_0, the coefficient of age β_1 and the coefficient of height β_2 obtained from the application of Cramer's rule through MATLAB computation are the same as with SPSS output. The predicted body mass values were compared favourably with the original sample data. Since the estimated body masses are consistent with the sample data, the model is properly fitted. Therefore, Cramer's rule is reliable for the analysis of multiple linear regression models. Two students with a BMI of 25.11 kg/m^2 and 25.07 kg/m^2 respectively were overweight. Although overweight is not an illness, it may be a condition of potential health risk for these students.

Recommendations

To avoid being overweight or obese which may be a potential condition of health risk, individuals should regularly:

i know their body mass index;

ii Engage in physical exercise;

iii Seek professional dietary advice so as to maintain a balanced diet.

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