DETERMINING THE BEST MODEL ON THE EFFECT OF OVERWEIGHT ON ADULT INDIVIDUAL USING MULTIPLE REGRESSION ANALYSIS

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Abstract
This study examine the best model that determine the effect of overweight on adult individuals using multiple regression analysis. One hundred and sixty (160) healthy individuals were used for the study, and the variables of interest were Age, Sex, and Height. The multiple regression analyses were carried out to determine the best model that estimate the overweight of an adult individual using the variables of interest. The data were collected using digital scale for measuring subject's weight, meter rule for measuring subject's height to the nearest 0.00m. Percentage distribution of the body weight categories of the subjects based on Body Mass Index (BMI); 45% of the subjects were at abnormal weight that is (underweight 3%, overweight 32% and obese 10%), and normal weight 55%.The study indicates that weight can serve as a positive indicator of studying overweight in the selected communities; and the Multiple regression equation $\hat{y} = -0.548 + 0.213(Age) + 35.833(Height) - 0.913(Sex)$ *was the best model. However, it may not be used to determine underweight in adults. Regular BMI and weight screening is recommended as an easy and effective means of assessing body weight and in the prevention of weight related diseases in adults.*

Keywords: Overweight, BMI, Regressing, Underweight and Obese

Introduction
The term body weight is used in the biological and medical sciences; it is referred to as a person's mass. The human Body weight is measured in kilograms. Measurement of mass or weight is in kilogram throughout the world, except for some countries such as United States which used pounds in measuring weight. Also in United Kingdom units like stones and pounds are used in measuring weight (Robinson e tal, 1983).

The human body weight is the mass of a person taken without any items on, but practically it is negligible to take the human body weight with clothes on but often without the shoes and heavy accessories like phones, jewelries, wrist watches and wallet. Body weight is one way of determining a person's health.Ideal Body Weight was initially introduced by Devine in1974 to allow estimation of drug clearances in obese patients.

In this paper measurements of weight, height, age, and gender were collected and the experiment designed was to determine the best model that fitted the determination of overweight and whether or not there exist a relationship between the Ideal Body Weight for any individuals given his/her height, age and gender (Sex)..
Many Nigerians do not care about knowing their weight and what exactly they should weight, research has shown that this happened not because they have no access to scale, but rather

they are not just interested in measuring their weights. Over weight don't just occur but it started from a stage that many Nigerians don't know due to their negligence to weight measurement. Many Nigerians have lost their life to overweight because they do not know they are overweighing. The goal of this study is to help adults to know his/her weight by simple computation and estimation without climbing a scale or the use of other measuring devices.

However, there is no variable for measuring human fatness, but weight can be measured as it is a body mass. As such one cannot say is at normal weight, underweight or overweight without relating weight to the factor variables (height, age and gender).

Review on Overweight and Obesity

Overweight is a common chronic ailment, from 20 to 50per cent of adults in the United States are overweight (Stewart 1980). Most research on the effects of being overweight has focused on the relationship between being overweight and the prevalence of various chronic diseases, such as diabetes and heart disease, or on premature mortality.

According to WHO (2000), in recent years, occurrence of Overweight and obesity are very high affecting both developed and developing countries like India. In the works of James, Leach, Kalamara and Shayeghi (2004). Obesity is associated with a large number of debilitating and life threatening disorders, such as cardiovascular, metabolic and other non-communicable diseases.The causes of adult obesity include a variety of factors like diet, genetic predisposition, lack of physical activities and other behavioral factors.

According to Wilborn, Beckham, Jequier and Tappy (2005) the prevalence of obesity is increasing worldwide and it has become a significant health hazard. Obesity rates have now reached epidemic proportions in the western hemisphere constituting over 25% of population in US and 15% in Europe.

Prevalence of obesity in India is up to 50% inwomen and 32.2% among Men in the upperstrata of the society. In Delhi, the prevalence of obesity is 33.4% in urban women and 21.3% in Men according to Gopinath, Chadha, Jain, Shekhawat, Tandon (1994). Obesity and overweight are not only a problem of adults but also of the children and adolescents worldwide. Even in famine stricken country like Ethiopia 25% of adolescents werefound to be obese. In India little attention has been paid to childhood and adolescent obesity until recently, Jugesh Chhatwal (2004).Studies on medical students and health personnel in many countries, suggest that obesity is a problem among these population groups11-15. Overweight and obesity have been considered a serious health problem worldwide since 1997 (WHO, 2000). Both developed and developing countries are experiencing increasing rates of overweight and obesity. Overweight and obesity are the fifth leading risk for global deaths; at least 2-8 million adults die each year as a result of being overweight or obese. In addition, 44% of the diabetes burden, 23% of the ischemic heart disease burden, between 7% and 41% of certain cancer burdens are attributable to overweight and obesity. Once considered a high-income country problem, overweight and obesity are now on the rise in low – and middle-income Countries, particularly in urban settings. Close to 35 million overweight children are living in developing countries and 8 million in developed countries. Overweight and obesity are linked to more deaths worldwide than underweight. For example, 65% of the world's population live in countries were overweight and obesity kill more people than underweight (this include the high income and most middle-income countries) (WHO May, 2012).

Nigeria is witnessing both demographic and epidemiologic transitions and these could be some of the possible reasons why the prevalence of non-communicable diseases is increasing (Adeyemo, Luke, Cooper, Wu, Tayo, Zhu, Rotimi, Bouzekri, and Ward, 2003). There is a general misconception in Nigeria that obesity is a sign of affluence (Adeyemo et al 2003).

Ojofeitimi etal (2007) found that 21.2% of their respondents were obese, while Kadiri, Salako (2007) and Adeogun (2011) also found obesity in 21% and 28% of males and females respectively in a study of 146 middle-aged Nigerians. Similarly, Ben-Bassey, Oduwole and Ogundipe (2007), observed that in many of the urban centers of the developing Countries, a change in lifestyle due to increased affluence has been observed, and this change in lifestyle is an important factor in the global epidemic of overweight and obesity. Also as observed by Adeogun, Setonji and Owoyemi (2010), the obesity epidemic is especially evident in industrialized nations where many people live sedentary lives and eat more convenience foods, which are typically high in calories and low in nutritional value.

Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have an adverse effect on health (WHO, 2000). Obesity increases the likelihood of various diseases, particularly heart disease, type 2 diabetes, breathing difficulties during sleep, certain types of cancer and osteoarthritis.(Wilborn e tal, 2005).

Pieniak, etal (2009), a BMI of 30-35 reduces life expectancy by two to four years, while severe obesity (BMI>40) reduces life expectancy by 10 years. Like many other medical conditions, obesity is the result of interplay between genetic and environmental factors(Whitlock et al., 2009). The percentage of obesity that can be attributed to genetics varies, depending on the population examined, from 6-85%. An individual level, a combination of excessive caloric intake and a lack of physical activity are thought to explain most cases of obesity (Ogden et al., 2007). A limited number of cases are due primarily to genetics, medical reasons, or psychiatric illness. In contrast, increasing rates of obesity at a societal level are felt to be due to an easily accessible and palatable diet. (Sodjinou, 2000; James, 2004).

Abbate e tal (2006). identified ten other possible contributors to the recent increase of obesity: (1) insufficient sleep, (2) endocrine disruptors (environmental pollutants that interfere with lipid metabolism), (3) decreased variability in ambient temperature, (4) decreased rates of smoking, because smoking suppresses appetite, (5) increased use of medications that can cause weight gain (e.g. atypical antipsychotics), (6) proportional increases in obesity ethnic and age groups that tend to be heavier, (7) pregnancy at a later age (which may cause susceptibility obesity and family background.to obesity in children), (8) epigenetic risk factors passed on generationally, (9) natural selection for higher BMI and (10) Assortative mating leading to increased concentration of obesity risk factors (this would not necessarily increase the number of obese people, but would increase the average population weight).

Some Causes of Overweight and Obesity

Overweight and obesity happen over time when you take in more calories than you use.According to WHO many Americans aren't very physically active. One reason for this is that many people spend hours in front of TVs and computers doing work, Schoolwork, and leisure activities. In fact, more than 2 hours a day of regular TV viewing time has been linked to overweight and obesity. Other reasons for not being active include: relying on cars instead of walking, fewer physical demands at work or at home because of modern technology and conveniences, and lack of physical education classes in Schools. People who are inactive are more likely to gain weight because they don't burn the calories that they take in from food and drinks. An inactive lifestyle also raises your risk for coronary heart disease, high blood pressure, diabetes, colon cancer, and other health problems.

Our environment doesn't support healthy lifestyle habits; in fact, it encourages obesity. Some reasons include:Lack of neighborhood sidewalks and safe places for recreation. Not having area parks, trails, sidewalks, and affordable gyms makes it hard for people to be physically active work schedules. People often say that they don't have time to be physically active because of long work hours and time spent commuting. Overweight and obesity tend to run in families. Your chances of being overweight are greater if one or both of your parents are overweight or obese (National Institutes of Health, NIH, 2012).Your genes also may affect the amount of fat you store in your body and where on your body you carry the extra fat. Because families also share food and physical activity habits, a link exists between genes and the environment.

Children adopt the habits of their parents. A child who has overweight parents who eat high-calorie foods and are inactive will likely become overweight too. However, if the family adopts healthy food and physical activity habits, the child's chance of being overweight or obese is reduced.

Some hormone problems may cause overweight and obesity, such as underactive thyroid (hypothyroidism), Cushing's syndrome, and polycystic ovarian syndrome (PCOS).Underactive thyroid is a condition in which the thyroid gland doesn't make enough thyroid hormone and lack of thyroid hormone will slow down your metabolism and cause weight gain. You'll also feel tired and weak.

Cushing's syndrome is a condition in which the body's adrenal glands make too much of the hormone cortisol. Cushing's syndrome also can develop if a person takes high doses of certain medicines, such as prednisone, for long periods.People who have Cushing's syndrome gain weight, have upper-body obesity, a rounded face, fat around the neck, and thin arms and legs.

Certain medicines may cause you to gain weight. These medicines include some corticosteroids, antidepressants, and seizure medicines. These medicines can slow the rate at which your body burns calories, increase your appetite, or cause your body to hold on to extra water. All of these factors can lead to weight gain.
Some people eat more than usual when they're bored, angry, or stressed. Over time, overeating will lead to weight gain and may cause overweight or obesity. While some gain weight when they stop smoking. One reason is that food often tastes and smells better after quitting smoking. Another reason is because nicotine raises the rate at which your body burns calories, so you burn fewer calories when you stop smoking. However, smoking is a serious health risk, and quitting is more important than possible weight gain.

As you get older, you tend to lose muscle, especially if you're less active. Muscle loss can slow down the rate at which your body burns calories. If you don't reduce your calorie intake as you get older, you may gain weight. Midlife weight gain in women is mainly due to aging and lifestyle, but menopause also plays a role. Many women gain about 5 pounds during menopause and have more fat around the waist than they did before.During pregnancy, women gain weight to support their babies' growth and development. After giving birth, some women find it hard to lose the weight. This may lead to overweight or obesity, especially after a few pregnancies.

Material and Methods

This study was carried out between August and September, 2014 at Zone A, B and C, that is Minna, Bida and Kontagora in Niger state, Nigeria. A total of 160 healthy subjects, aged between 18 and 65 years were randomly selected for the study. A simple random sampling technique was used to select the subject and none of the female subjects was pregnant at the period of the study. After obtaining their consent the age, sex, height (m) and weight (kg) of the subject were recorded.Weight was measured using digital balance to the nearest whole number (0kg) ensuring that the subject is not putting on heavy objects. Height was measured using meter rule to the nearest 0.01 meter with the subject standing upright, barefooted, without cap or headgear. Body Mass Index was defined according to WHO cut-offs as follows:Underweight as 18.4kg/m^2 or below;Normal weight as 18.5kg/m^2 – 24.9kg/m^2;Overweight as 25.0kg/m^2 – 29.9kg/m^2;Obese as BMI of 30kg/m^2 or greater.BMI was calculated as weight (kg)/height (m^2).

Regression analysis is widely used for prediction and forecasting, where it is used as substantial overlap with the field of machine learning. The performance of regression analysis methods in practice depends on the form of the data generating process, and how it relates to the regression approach being used. Since the true form of the data-generating process is generally not known, regression analysis often depends to some extent on making assumptions about the process.

Multiple Linear Regression Model

A regression model that contains more than one regressor variable is calleda multiple regression model. A multiple linear regression model is the Mathematics of stating the statistical relationship between one variable (dependent variable) and two or more other variables (independent variables). In this study the weight of an adult individual depends on the height, age and gender (Sex). A multiple regression model that might describe this relationship is $Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \varepsilon_i$ (2.1)

Where Y represents the weight, x_1 represents the height,$x_2$represents the age,$x_3$represents the gender (sex) and ε_i is a random error term. This is a multiple linear regression modelwith three regressors. The termlinearis used because Equation (2.1) is a linear function of the unknown parameters β_0, β_1, β_2, and β_3.

Where we have assumed that the expected value of the error term is zero; that is E (ε) =0.
The parameter$\beta_0$is the interceptof the plane,β_1, $\beta_2$and$\beta_3$partialregression coefficients,because β_1 measures the expected change in Y per unit change in x_1 when$x_2$and$x_3$are held constant, $\beta_2$measures the expected change in Y per unit change in x_2 when x_1 and x_3,are held constant and $\beta_3$measures the expected change in Y per unit change in x_3,when $x_1$and x_2 are held constant.

Least Square Estimation of the Parameters

The method of least squaresmay be used to estimate the regression coefficients in the Multiple

Regression model, Equation (2.1.) Suppose that n >kobservations are available, and let x_{ij}denote the ith observation or level of variable x_j.The observations are(x_{i1}, x_{i2},x_{ik}, y_i), i = 1, 2, ..., n and n>k. It is customary to present the data for multiple regression in a table such as Table 2.1.

Each observation (x_{i1}, x_{i2}...x_{ik}, y_i), satisfies the model in Equation (2.1)

$$Y_i = \beta_0 + \sum_{j=1}^{k} \beta_j x_{ij} + \varepsilon_i \qquad i = 1, 2, \dots, n$$

The least square function is:$L = \sum_{i=1}^{n} \varepsilon_i^2 = \sum_{i=1}^{n} (y_i - \beta_0 - \sum_{j=1}^{k} \beta_j x_{ij})^2$By minimizing L with respect to β_0, β_1, ., β_k. The Least Square Estimate of β_0, β_1, . . , β_k are$\beta_0 = \bar{y} - \sum_{i=1}^{k} (\beta_i \bar{x}_i)$ $and \beta_k = \frac{SS_{xy}}{SS_{xx}}$. Where,

$SS_{xy} = n \sum_{i=1}^{n} x_{ki} y_i - (\sum_{i=1}^{n} x_{ki})(\sum_{i=1}^{n} y_i)andSS_{xx} = n \sum_{i=1}^{n} x_{ki}^2 - (\sum_{i=1}^{n} x_{ki})^2$.Where n is the number of observations from the normal population for β_0 and β_k and k is the number of the independent variables.

Underlying Assumptions

Classical assumptions for regression analysis include; the sample is a representative of the population for the inference prediction; the error is a random variable with a mean zero conditional on the explanatory variables; the independent variables are measured with no error. (Note: if this is not so, modeling may be done instead using error-in-variables model techniques); The predictors are linearly independent, i.e. it is not possible to express any predictor as a linear combination of the others; The errors are uncorrelated, that is, the variance-covariance matrix of the errors is diagonal and each non-zero element is the variance of the error; The variance of the error is constant across observations (homoscedasticity). (Note: if not, weighted least squares or other methods might instead be used).

Interpolation and Extrapolation

Regression model predicts a value of the Y variable given known values of the X variables. Prediction within the range of values in the dataset used for model-fitting is known informally as interpolation. Prediction outside this range of the data is known as extrapolation. Performing extrapolation relies strongly on the regression assumptions. The further the extrapolation goes outside the data, the more room there is for the model to fail due to differences between the assumptions and the sample data or the true values.

Lindley (1987) advised that when performing extrapolation, one should accompany the estimated value of the dependent variable with a prediction interval that represents the uncertainty. Such intervals tend to expand rapidly as the values of the independent variable(s) moved outside the range covered by the observed data.

Table 2.1: Analysis of variance (ANOVA) for testing significance of regression in multiple regression

Source of variation	Sum of squares	Degrees of freedom	Mean squares	F_0
Regression	SS_R	K	MS_R	MS_R/MS_E
Error	SS_E	n-p	MS_E	
Total	SS_T	n-1		

Source: Any Standard Statistics textbook.

Where, K is the degree of freedom, depending on the number of independent variable X
$SST = n\sum_{i=1}^{n} y_i^2 - (\sum_{i=1}^{n} y_i)^2 = SS_{yy}$ and $SSR = \sum_{i=1}^{n} y_i^2 - \beta_0 \sum_{i=1}^{n} y_i - \beta_1 \sum_{i=1}^{n} x_1 y - \cdots \beta_k \sum_{i=1}^{n} x_k y$ i.e. $SSE = SST - SSR$

Data Analysis and Interpretation

Analysis of the data which as presented in Appendix I is made using SPSS software, coding the categorical data Male=0 and Female =1. Interpretations of the results of analysis were also performed.

Table 3.1: Classification of the subject based on BMI cut-offs

Underweight 18.4kg/m^2 or below	Normal weight 18.5kg/m^2–24.9kg/m^2	Overweight 25.0kg/m^2 – 29.9kg/m^2	Obese 30.0kg/m^2 or greater
4	88	51	17

Table 3.1 is a refinement of data in Appendix I; Percentage distribution of the body weight categories of the subjects based on BMI; 45% of the subjects are at abnormal weight that is (underweight 3%, overweight 32% and obese 10%), and normal weight 55%. Out of a total of the 160 subjects, 104 in early adulthood (18-39years), 38 in middle adulthood (40-59years) and 18 in advanced adulthood (60 and above).

Result and Analysis for the Regression between age, height, sex and weight

The relationship between the variables age, height, sex and weight was obtained using a Statistical Software (SPSS 20). The result of the analysis is shown in Table 3.2.

Table 3.2Coefficients of β_0, β_1, β_2, and β_3

Model		Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	-.548	12.030		-.046	.964	-24.311	23.214
	Age	.213	.056	.288	3.813	.000	.103	.323
	Height	35.833	7.233	.366	4.954	.000	21.546	50.119
	Sex	-.913	1.613	-.042	-.566	.572	-4.100	2.273

a. Dependent Variable: Weight

From Table 3.2, the fitted regression model is

$$\hat{y} = -0.548 + 0.213(Age) + 35.833(Height) - 0.913(Sex) \quad (3.1)$$

Here y, is the dependent variable, which is the weight, while Age, Height and Sex are the independent or explanatory variables respectively.This implies that 0.213, 35.833and -0.913 are the average changes in y per unit change in Age, Height and Sex. Furthermore, Sex contributed negatively to the model.

Testing the Significance of the R**egression Parametersβ_0, β_1, β_2, and β_3**

From Table 3.2 the coefficients of the β_0, β_1, β_2, and $\beta_3$are –0.548. 0.213, 35.833 and -0.913 respectively, with Age and Height are significant and contributed positively to the model with height contributing the highest value of 35.833, while sex contributes negatively, thus not significant at 5% level of significant

Table 3.3: Model Summary for Regression between Age, Height, Sex and Weight

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.568[a]	.323	.310	8.849	.323	24.811	3	156	.000

a. Predictors: (Constant), Sex, Height, Age
b. Dependent Variable: Weight

From R is the correlation value (0.568), which implies that there exists an average positive relationship between the dependent variable (weight) and the independent variables (age height and sex). R^2 is 0.323this means that approximately 32% of the variability of weight is accounted for by the model for this data with significant F change.

Table 3.4: ANOVA for the regression parameters; age, height, sex and weight

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5828.815	3	1942.938	24.811	.000[a]
	Residual	12216.429	156	78.310		
	Total	18045.244	159			

a. Predictors: (Constant), Sex, Height, Age
b. Dependent Variable: Weight

From table 3.4, the P- value = 0.000is less than 5% level of significant; which means that our regression model is significant. Thus, we conclude that the model explains a statistically significant portion of the variability in the weight from the predictors: age, height and sex. Accept that at least one of the parameters is significant.

3.395% Confidence Interval for Regression Parameters

From table 3.2, the confidence intervals have been as; for β_0 is between (-24.311, 23.214); for β_1 is between (0.103 0.323); for β_2 is between (21.546 50.119); and for β_3 is between (-4.100 2.273).

The intercept β_0 (-0.568) falls within the interval (-24.311 23.214) at 95% C.I. The regression Parameter β_1 (0.213) falls within the interval (0.103 0.323) at 95% C.I. The regression

Parameter β_2 (35.833) falls within the interval (21.546 50.700) at 95% C.I. And also the regression Parameter β_3 (-0.913) falls within the interval (-4.100 2.273) at 95% C.I

Result and Analysis for the Regression of Weight on Age and Height

Table 3.5 Coefficients β_0, β_1, and β_2

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-3.135	11.104		-.282	.778	-25.068	18.797
	Age	.223	.053	.302	4.232	.000	.119	.327
	Height	36.840	6.995	.376	5.266	.000	23.023	50.657

a. Dependent Variable: Weight

From Table 3.5, the fitted regression model is $\hat{y} = -3.135 + 0.223(Age) + 36.84(Height)$(3.2)
Here y, is the dependent variable, which is the weight, while Age and Height are the independent or explanatory variables respectively. This implies that 0.223and 36.840 are the average changes in y per unit change in Age and Height.

Testing the Significance **of the Regression Parameters β_0, β_1, and β_2**
From Table 3.5; Both Age and Height are significant when Sex as a variable is step-down from the model for the dataset available for the study, although Height contributed much higher value of 36.840

Table 3.6: Model summaryfor the regression of weight on age and height

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.567[a]	.322	.313	8.830	.322	37.217	2	157	.000

a. Predictors: (Constant), Height, Age
R is the correlation value (0.567), which implies that there exists an average positive relationship between the dependent variable (weight) and the independent variables (Age and height). R^2 is 0.322 this means that approximately 32% of the weight is explained by the combination of Age and Height (m)

Table 3.7 ANOVA for the Regression Parameter Age, Height and Weight

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5803.716	2	2901.858	37.217	.000[a]
	Residual	12241.528	157	77.972		
	Total	18045.244	159			

a. Predictors: (Constant), Height, Age
b. Dependent Variable: Weight

From table 3.7, the P- value = 0.000 is less than 5% level of significant; which means that our regression model is significant. Thus, we conclude that the model explains a statistically significant portion of the variability in the weight from the predictors: Age and Height. Accept that at least one of the parameters is significant.

Result and Analysis for the Regression of Weight on Age and Sex

Table 3.8: Coefficients β_0, β_1, and β_3

Model		Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	57.687	2.726		21.162	.000	52.303	63.071
	Age	.291	.057	.394	5.122	.000	.179	.404
	Sex	-2.955	1.661	-.137	-1.778	.077	-6.236	.327

a. Dependent Variable: Weight

From Table 3.8, the fitted regression model is: $\hat{y} = 57.687 + 0.291(Age) - 2.955(Sex)$ (3.3)Here y, is the dependent variable, which is the weight, while Age and Sex are the independent or explanatory variables respectively. This implies that 0.291 and -2.955 are the average changes in Y per unit change in Age and Sex.

Testing the Significance of the Regression Parameters β_0, β_1, and β_3

From Table 3.8; the value for Age is significant and contributed positively to the model, while Sex is not significant at 5% level and contributed negatively to the model based on the dataset for this study. This means that the model is not a good model for predicting weight.

Table 3.9: Model summaryfor the regression of weight on age and sex

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.466[a]	.218	.208	9.483	.218	21.825	2	157	.000

a. Predictors: (Constant), Sex, Age
b. Dependent Variable: Weight

R is the correlation value (0.466), which implies that there exists a very weak positive relationship between the dependent variable (weight) and the independent variables (Age and Sex). R^2 is 0.218 is low;this means that approximately 22% of the variability of weight is accounted for by the model.

Table 3.10: ANOVA for the regression of weight on age and sex

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3925.626	2	1962.813	21.825	.000[a]
	Residual	14119.617	157	89.934		
	Total	18045.244	159			

a. Predictors: (Constant), Sex, Age
b. Dependent Variable: Weight

From Table 3.10, the P- value = 0.000 is less than 5% level of significant; which means that our regression model is significant. Thus, we conclude that the model explains a statistically significant portion of the variability in the weight from the predictors: Age and Sex. Accept that at least one of the parameters is significant.

Result and Analysis for the Regression of Weight on Height and Sex

Table 3.11: Coefficients $\beta_{0,}, \beta_{2,}$ **and** β_3

Model		Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	-4.761	12.455		-.382	.703	-29.363	19.840
	Sex	-2.866	1.590	-.133	-1.803	.073	-6.006	.274
	Height	43.688	7.219	.446	6.052	.000	29.430	57.947

a. Dependent Variable: Weight

From Table 3.11, the fitted regression model is: $\hat{y} = -4.761 + 43.688(Heig\square t)$ −2.866(Sex) (3.4)

Here y, is the dependent variable, which is the weight, while Height and Sex are the independent or explanatory variables respectively. This implies that 43.688and -2.866 are the average changes in y per unit change in Height and Sex.

Testing the Significance of the Regression Parameters $\beta_{0,}$ $\beta_{2,}$ **and** β_3

From Table 3.1, the P-value= 0.000 is less than 5% level of significant for Height, this implies Height is significant while P-Value = 0.073 is greater than 5%, sex is not significant. This means that the model is not adequate for predicting weight.

Table 3.12: Model Summaryfor the Regression of Weight on Height and Sex

Model Summaryb

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.509[a]	.260	.250	9.225	.260	27.517	2	157	.000

a. Predictors: (Constant), Height, Sex

b. Dependent Variable: Weight

R is the correlation value (0.509), which implies that there exists aaverage positive relationship between the dependent variable (weight) and the independent variables (Height and Sex). R^2 is 0.260 this means that approximately 26% of the variability of weight is accounted for by the model. Implies is not a good model based on the dataset for estimating weight.

Table 3.13: ANOVA for the Regression Parameter Height, Sex and Weight

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4683.640	2	2341.820	27.517	.000[a]
	Residual	13361.604	157	85.106		
	Total	18045.244	159			

a. Predictors: (Constant), Height, Sex
b. Dependent Variable: Weight

From Table 3.13, the P- value = 0.000 is less than 5% level of significant; which means that our regression model is significant. Thus, we conclude that the model explains a statistically significant portion of the variability in the weight from the predictors: Height and Sex. Accept that at least one of the parameters is significant.

Analysis of Goodness of fit test using Absolute Mean Deviation (MAD)

$MAD = \sum_{i=1}^{n} |\varepsilon_i| \cdot \frac{1}{n} = \sum_{i=1}^{n} |y_i - \hat{y}| \cdot \frac{1}{n}$ Where, n = 160 and

$\sum_{i=1}^{160} |\varepsilon_i| = 1301.657$ i.e. MAD =1301.657/160 = 8.135 ≈ 8kg

This means that the estimated weight of an individual with regards to his age, height and sex may deviate with an average of 8kg based on this study.

Discussion of Results

From the analysis of the results obtained in the section 3, it is evidence that the three variables that is age, height and sex are more significant in Table 3.4, Table 3.7, and 3.10. The various tests of significant show that regressing weight on age, height and sex gives the best fitted model on estimating weight. Regressing weight on age and height gives a better model than when weight is regress on sex and height or age and sex respectively. Sex and age alone could not estimate weight as the model fitted by regressing weight on age and sex could not predict better.

In conclusion, regressing weight on age, height and sex gives the best model in predicting weight of an adult individual with a mean deviation of 8kg based on this study.

Therefore, age, height and sex account for about 32% of human weight. Other factors such as exercise, eating habit, metabolic rate, constitute or make up the remaining 68% factors or variables that determine human weight (Harry Mills, 2005).

Finally, it is shown that an estimated weight of a person may deviate with an average weight of 8kg.

It is obvious that naturally weight, height and age are related, it thus provides an insight on how one can utilize his/her body. Regular visitation to a medical personnel's is hereby encouraged to monitor one's body since all the parameters are proportional to each other. The model obtained can serve as a watcher in other to be able to monitor your body weight to see if you are at abnormal or at normal weight, in accordance to the BMI cut-offs.

Overweight can be checked by increasing ones physical activity for at least 3 to5days per week. Food with high fat or sugar intake should be reduced and increase the intake of foods with low energy such as fruits and vegetables. Food with high fibres and water are recommended for adults with overweight. Excessive weight gain of more than 5kg should be avoided by regular exercise, increase intake of vegetables and fruits and regular medical checkups to avoid or reduce the risk of chronic diseases.

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APPENDIX I

Dataon Age (Years), Height (m), Sex and Weight (Kg) of Respondents.

S/No.	Age	Height(m)	Sex	Weight(kg)
1	25	1.84	Female	65
2	27	1.86	Male	75
3	43	1.73	Female	68
4	49	1.79	Male	80
5	37	1.71	Male	55
6	44	1.98	Male	65
7	25	1.84	Female	75
8	48	1.87	Female	70
9	43	1.86	Male	65
10	41	1.67	Male	75
11	42	1.72	Male	80
12	39	1.73	Female	65
13	33	1.74	Female	68
14	35	1.75	Male	70
15	37	1.69	Male	80
16	16	1.32	Male	42
17	15	1.52	Female	41
18	14	1.62	Male	45
19	60	1.81	Male	80
20	40	1.79	Male	83
21	45	1.73	Female	75
22	18	1.53	Female	45
23	15	1.56	Male	49
24	40	1.80	Female	75
25	38	1.70	Female	75
26	36	1.67	Male	75

27	25	1.69	Male	55
28	27	1.68	Female	60
29	33	1.72	Male	75
30	40	1.73	Male	80
31	32	1.76	Female	78
32	27	1.67	Male	60
33	18	1.27	Female	45
34	19	1.33	Female	45
35	22	1.35	Male	50
36	36	1.67	Male	75
37	25	1.69	Male	55
38	27	1.68	Female	60
39	33	1.72	Male	75
40	33	1.77	Female	73
41	32	1.75	Female	55
42	26	1.73	Male	65
43	39	1.72	Male	70
44	30	1.67	Female	64
45	25	1.69	Male	65
46	29	1.78	Female	60
47	27	1.65	Female	60
48	24	1.63	Female	65
49	22	1.63	Male	75
50	23	1.61	Female	66
51	26	1.77	Male	69
52	27	1.87	Male	73
53	25	1.82	Male	65
54	27	1.73	Male	60
55	24	1.81	Male	65
56	22	1.65	Male	72
57	21	1.90	Male	86
58	53	1.72	Male	72
59	26	1.65	Male	75
60	23	1.75	Female	57
61	21	1.60	Female	49
62	22	1.67	Female	72
63	28	1.63	Female	64
64	34	1.64	Female	69
65	30	1.63	Female	52
66	36	1.55	Female	46
67	33	1.58	Female	83
68	21	1.74	Female	64
69	37	1.57	Female	65
70	24	1.55	Female	84
71	23	1.56	Female	63
72	24	1.51	Female	75
73	23	1.53	Female	79
74	29	1.57	Female	65

75	23	1.68	Female	67
76	26	1.57	Female	62
77	28	1.60	Female	77
78	20	1.60	Female	63
79	26	1.57	Female	50
80	25	1.58	Female	55
81	24	1.63	Female	55
82	25	1.60	Female	51
83	34	1.67	Female	85
84	22	1.60	Female	64
85	34	1.61	Female	82
86	28	1.70	Female	59
87	20	1.52	Female	50
88	33	1.63	Female	61
89	32	1.59	Female	50
90	29	1.66	Female	67
91	41	1.63	Female	53
92	25	1.62	Female	70
93	30	1.67	Female	63
94	28	1.64	Female	71
95	32	1.72	Female	55
96	29	1.61	Female	83
97	32	1.62	Female	48
98	32	1.53	Female	57
99	28	1.66	Female	66
100	35	1.68	Female	68
101	25	1.62	Female	62
102	32	1.56	Female	58
103	25	1.55	Female	63
104	26	1.51	Female	51
105	27	1.66	Female	58
106	19	1.71	Female	70
107	35	1.61	Female	67
108	28	1.62	Female	58
109	27	1.60	Female	51
110	31	1.69	Female	77
111	37	1.66	Female	75
112	21	1.72	Female	82
113	35	1.64	Female	72
114	40	1.74	Female	70
115	23	1.66	Female	72
116	26	1.50	Female	46
117	22	1.58	Female	52
118	29	1.55	Female	52
119	30	1.59	Female	60
120	45	1.75	Female	74
121	47	1.69	Female	80
122	60	1.75	Male	74

123	63	1.72	Male	68
124	58	1.69	Male	78
125	65	1.65	Male	75
126	69	1.67	Male	63
127	49	1.52	Male	55
128	67	1.73	Male	89
129	55	1.53	Female	68
130	51	1.78	Male	71
131	50	1.50	Female	56
132	58	1.72	Male	78
133	61	1.70	Female	66
134	67	1.77	Male	83
135	75	1.79	Male	80
136	54	1.60	Female	57
137	48	1.69	Male	75
138	46	1.74	Male	70
139	62	1.80	Female	69
140	71	1.65	Male	85
141	67	1.73	Male	82
142	49	1.66	Male	69
143	45	1.59	Male	72
144	35	1.60	Male	67
145	41	1.78	Male	65
146	59	1.62	Female	65
147	48	1.60	Male	74
148	64	1.75	Male	85
149	51	1.82	Male	71
150	57	1.85	Male	69
151	53	1.89	Male	61
152	68	1.79	Male	70
153	65	1.74	Male	68
154	49	1.77	Male	59
155	61	1.82	Male	73
156	66	1.68	Male	77
157	52	1.73	Male	78
158	49	1.70	Female	63
159	52	1.72	Female	74
160	62	1.74	Female	71