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Multiple Regression Analysis of Basal Metabolic Rate Using Dataset of 50 Adults at Federal Medical Center, Otuoke Outreach

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Authors' contributions

This work was carried out in collaboration among all authors. Authors KWB, SL and JBG designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SL and JBG managed the analyses of the study. Authors JBG and KWB managed the literature searches. All authors read and approved the final manuscript.

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Abstract

This data analysis aimed at investigating Basal Metabolic Rate (BMR) of patients around Otuoke region, in Ogbia Local Government Area, and the data were collated at Federal Medical Centre, Otuoke Outreach. The data collated involving 50 patients, of which, 25 are males and 25 female volunteers of different ages. The variables involved in this analysis include age, gender and basal metabolic index, using SPSS version 25. Descriptive analysis was carried out to summarize the data in terms of mean and standard deviation of the gender and age. Biserial correlation was carried out on gender, age and BMR, and Cohen standard was done to investigate the strength of the relationship between the variables. The results of the analysis showed a negative correlation between gender and BMR with a correlation coefficient of -0.70, indicating a large effect size. In addition, it is seen that the linear regression model is significant, $F(2,47) = 25.09$, $p<0.001$, and $Rsq = 0.52$, indicating 52% variance in BMR. The result goes further to reveal that a unit increase in age doesn't cause an effect on BMR. However, the female

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category can significantly predict BMR, B = -267.10, t(47) = -7.06, p<0.001. Based on this sample, this suggests that moving from the Male to Female category of Gender will decrease the mean value of BMR by 267.10 units on average.

Keywords: Basal metabolic rate; multiple regressions; age; gender.

1 Introduction

World Health Organization (WHO) reported in [1] 2014 that there are over 2 billion people suffering from overweight. This report also showed that about 30 percent of the population is obese, and this amount tripled the previous decade. This increment was mainly ascribed to an imbalance between energy intake (EI) and energy expenditure (EE) This trend has raised concern to many as obesity is a major cause of many diseases such as cardiovascular diseases, diabetes and some cancers, hence the need for weight management cannot be over emphasized. Schofield and James [2] proposed a predictive equation for BMR and the equation accounts for about 65% of EE. This equation has been applied by many researches. One way to manage body weight is calories counting and a systematic nutritional plan. These methods are the most effective ways to achieve weight loss and help to balance the energy intake (EI) and energy expenditure (EE). EE is the total number of energy used or burned when the body is at rest plus calories burned during daily exercise. 70 percent of daily EE is from Basal Metabolic Rate (Trexler [3]). Basal Metabolic Rate (BMR) refers to the number of calories used while the body is at rest. BMR has frequently been one of the main focuses of attention in the recent studies of obesity. BMR depends on factors like age, physical activity, nutritional status and gender, with men having a greater BMR than females after adjustment for body composition. However, the aim of this investigation is to study to know the relationship between BMR, gender and age in Ogbia region, by collating secondary data from Federal Medical Centre, Otuoke Outreach.

2 Methodology

2.1 Data

The study recruited 25 males and 25 female adult volunteers. BMR of the volunteers were measured in the morning (between 8 and 10 AM) while they were still at rest. Ages of the volunteers were also recorded, and the data was presented in tabular form. Statistical analysis was performed using SPSS 25.0. Gender was treated as a categorical variable while BMR and age we scale variables. BMR was the dependent variable in the study.

2.2 Methods

Descriptive measures were calculated using SPSS 25. Statistics for age and BMR variables were given as mean and standard deviation, while percentage was used to summarize gender. A point Biserial correlation analysis (BCA) was conducted for Gender, Age and BMR. A point biserial correlation is a special case of the Pearson correlation. Cohen's standard was used to evaluate the strength of the relationships, where coefficients between .10 and .29 represent a small effect size, coefficients between .30 and .49 represent a moderate effect size, and coefficients above .50 indicate a large effect size (Cohen, [4]). A multiple regression analysis was conducted to assess whether Age and Gender significantly predicted BMR. A regression model is of the form.

3 Results and Discussion

3.1 Summary statistics

For Male, the observations of Age had an average of 33.64 (SD = 11.78, SE_M = 2.36, Min = 18.00, Max = 68.00, Skewness = 1.69, Kurtosis = 2.68). For Female, the observations of Age had an average of 27.72 (*SD*

= 6.59, SE_M = 1.32, Min = 18.00, Max = 46.00, Skewness = 0.64, Kurtosis = 0.67). For Male, the observations of BMR had an average of 1564.15 (*SD* = 152.71, SE_M = 30.54, Min = 1223.75, Max = 1947.50, Skewness = -0.05, Kurtosis = 0.81). For Female, the observations of BMR had an average of 1314.97 (*SD* = 101.01, SE_M = 20.20, Min = 1147.75, Max = 1510.25, Skewness = 0.29, Kurtosis = -0.58). When the Skewness is greater than 2 in absolute value, the variable is considered to be asymmetrical about its mean. When the kurtosis is greater than or equal to 3, then the variable's distribution is markedly different than a normal distribution in its tendency to produce outliers (Westfall & Henning [5]). The summary statistics can be found in Table 1.

Table 1. Summary statistics table for interval and ratio variables by gender

Variable	*M*	*SD*	*n*	SE_M	Min	Max	Skewness	Kurtosis
Age								
Male	33.64	11.78	25	2.36	18.00	68.00	1.69	2.68
Female	27.72	6.59	25	1.32	18.00	46.00	0.64	0.67
BMR								
Male	1564.15	152.71	25	30.54	1223.75	1947.50	-0.05	0.81
Female	1314.97	101.01	25	20.20	1147.75	1510.25	0.29	-0.58

Note. '-' indicates the statistic is undefined due to constant data or an insufficient sample size

3.2 Point biserial correlation analysis

The result of the correlations was examined using Holm corrections to adjust for multiple comparisons based on an alpha value of 0.05. There was a significant negative correlation between Gender and Age (r_{pb} = -0.30, *p* = .033, 95% CI [-0.54, -0.03]). The correlation coefficient between Gender and Age was -0.30 indicating a moderate effect size. This indicates that moving from the Male to Female category of Gender is associated with a decrease in Age. Therefore, the Female category of Gender tends to be associated with lower values of Age, and there is a significant negative correlation between Gender and BMR (r_{pb} = -0.70, $p < .001$, 95% CI [-0.82, -0.52]). The correlation coefficient between Gender and BMR was -0.70 indicating a large effect size. This indicates that moving from the Male to Female category of Gender is associated with a decrease in BMR. Therefore, the Female category of Gender tends to be associated with lower values of BMR. Table 2 presents the results of the correlation.

Table 2. Point biserial correlations for gender and age and BMR

Combination	r_{pb}	95% CI	*p*
Gender-Age	-0.30	[-0.54, -0.03]	.033
Gender-BMR	-0.70	[-0.82, -0.52]	< .001

Note .n = 50; Holm corrections used to adjust p-values

3.3 Linear regression analysis

The assumption of normality was assessed by plotting the quantiles of the model residuals against the quantiles of a Chi-square distribution, also called a Q-Q scatter plot (DeCarlo [6]). For the assumption of normality to be met, the quantiles of the residuals must not strongly deviate from the theoretical quantiles. Strong deviations could indicate that the parameter estimates are unreliable. Fig. 1 presents a Q-Q scatter plot of the model residuals. Homoscedasticity was evaluated by plotting the residuals against the predicted values (Bates et al. [7]; Field [8]; Osborne & Walters [9]). The assumption of homoscedasticity is met if the points appear randomly distributed with a mean of zero and no apparent curvature. Fig. 2 presents a scatter plot of predicted values and model residuals. Studentized residuals are calculated by dividing the model residuals by the estimated residual standard deviation. An observation with a Studentized residual greater than 3.27 in absolute value, the 0.999 quartile of a *t* distribution with 49 degrees of freedom, was considered to have significant influence on the results of the model. Fig. 3 presents the Studentized residuals plot of the observations. Observation numbers are specified next to each point with a Studentized residual greater than 3.27.

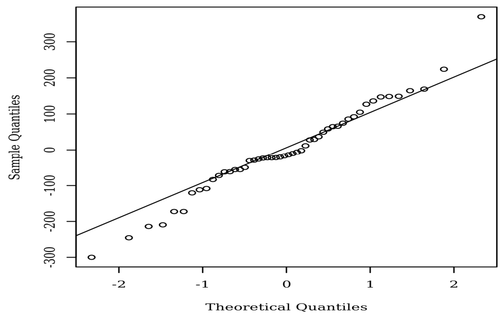

Fig. 1. Q-Q scatter plot for normality of the residuals for the regression model

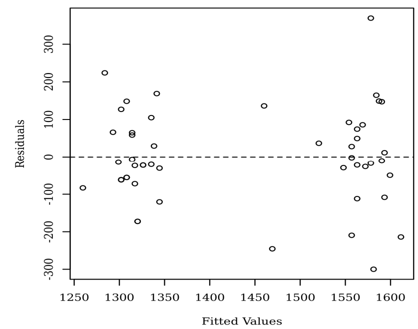

Fig. 2. Residuals scatter plot testing homoscedasticity

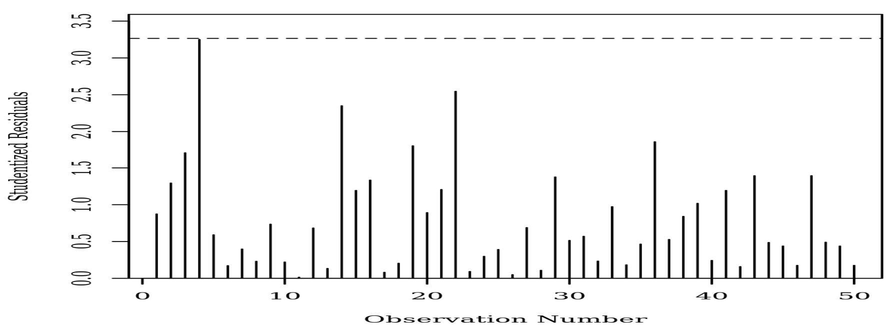

Fig. 3. Studentized residuals plot for outlier detection

Variance Inflation Factors (VIFs) were calculated to detect the presence of multicollinearity between predictors. High VIFs indicate increased effects of multicollinearity in the model. VIFs greater than 5 are cause for concern, whereas VIFs of 10 should be considered the maximum upper limit (Menard [10]). All predictors in the regression model have VIFs less than 10. Table 3 presents the VIF for each predictor in the model. To identify influential points, Studentized residuals were calculated and the absolute values were plotted against the observation numbers [8,11].

Table 3. Variance inflation factors for age and gender

Variable	**VIF**
Age	1.10
Gender	1.10

The results of the linear regression model were significant, $F(2,47) = 25.09$, $p< .001$, $R^2 = 0.52$, indicating that approximately 52% of the variance in BMR is explainable by Age and Gender. Age did not significantly predict BMR, $B = -3.03$, $t(47) = -1.57$, $p = .123$. Based on this sample, a one-unit increase in Age does not have a significant effect on BMR. The Female category of Gender significantly predicted BMR, B= -267.10, $t(47) = -7.06$, $p< .001$. Based on this sample, this suggests that moving from the Male to Female category of Gender will decrease the mean value of BMR by 267.10 units on average. Table 4 summarizes the results of the regression model.

Table 4. Results for linear regression with age and gender predicting BMR

Variable	*B*	*SE*	95% CI	β	*t*	*p*
(Intercept)	1666.00	69.73	[1525.72, 1806.27]	0.00	23.89	< .001
Age	-3.03	1.93	[-6.91, 0.85]	-0.17	-1.57	.123
Female	-267.10	37.84	[-343.22, -190.98]	-0.75	-7.06	< .001

Note. Results: $F(2,47) = 25.09$, $p < .001$, $R^2 = 0.52$

*Unstandardized Regression Equation: BMR = 1666.00 - 3.03*Age - 267.10*Female*

4 Conclusion

The work aims to analyze and explore the relationship between BMR, gender and age using data obtained from the Federal Medical Centre (FMC) Otuoke outreach. Based on the sample collected, we found that a significant amount of the variance in BMR was explainable by age and gender which conformed to other work done by different authors. Also, we noticed that a unit increase in age has no significant effect on BMR. A liner model was used to estimate BMR. From the model, we found that female category of gender significantly predicted BMR. We also noticed that moving from the Male to Female category of Gender will decrease the mean value of BMR by 267.10 units on average.

Competing Interests

Authors have declared that no competing interests exist.

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