THE ASSESSMENT OF ANTHROPOMETRY AND SELECTED BODY COMPOSITION PARAMETERS AS PREDICTOR OF BASAL METABOLIC RATEOF FEMALE UNIVERSITY UNDERGRADUATES

JAIYESIMI BOLUWAJI GBENGA
Department of Sports Science, Afe Babalola University, Ado-Ekiti

Abstract
This quasi-experimental study is based on the assessment of anthropometry and selected body composition parameters as predictor of basal metabolic rateof female university undergraduates. The sample consisted 110 female undergraduate students from the College of Medicine and Health Sciences in Afe Babalola University, Ado Ekiti. Age, height, weight and body composition parameters of Body Mass Index (BMI), Waist Circumference (WC), Hip Circumference (HC), Waist to Hip ratio (WHR), Waist to Height Ratio(WHtR) and Basal Metabolic Rate (BMR) of the students were variables considered for the study. The descriptive statistics of frequency, percentage counts, mean, standard deviation, standard error of mean, pearson product moment correlation coefficient and regression analysis were used for data analysis at 0.05 alpha level. The pearson product moment correlation coefficient results showed strong positive relationship between BMI and WC (r=.642), BMI and HC (.619), WC and HC (.649), WC and WHR(.713), BMI and BMR (.841), HC and BMR (.608), BMR and WC (.583). The regression result revealed that age r=.046(r^2=.002, p<.005)was not significant; height r=.328(r^2=.108, p<.005) was significant; weight r=.993(r^2=.987, p<.005) was significant; BMI r=.841(r^2=.707, p<.005) was significant; WC r=.583(r^2=.340, p<.005) was significant; HC r=.608(r^2=.369, p<.005) was significant; WHR r=.200(r^2=.040 p>.005) was not significant; WHtR r=.448(r^2=.200) was significant.In conclusion, the result of the findings showed that age and WHR were not significant predictors of BMR.

Keywords: *Anthropometry, Body composition parameters, Body mass index, Basal metabolic rate, waist to hip ratio.*

Introduction

Research studies on body composition and energy level are ongoing task that require concerted efforts of global health researchers. The mortality rate due to metabolic syndrome is no longer alarming but threatening. Measurement of anthropometric variables relating to body composition is a must concern for every government and stakeholders. The importance of measuring body composition has increased due to the need to evaluate changes in the nutritional status, which can affect body reserves differentially. One of the important aspects of health of individuals is their nutritional status, which is defined as a result of interaction of body composition, energy balance and body functionality (Gurpreet, Kiran, and Harpreet, 2012). Estimates of daily energy requirements are essential element of many aspects of public health nutrition, such as predicting national or population food requirements.

Anthropometry, like any other area of science, depends upon adherence to the particular rules of measurement as determined by national and international standard bodies. It is the measurement of body size, weight and proportions and can be defined as a technique in measuring a human body where anthropometric measurements are derived from anatomical landmarks. The measurements taken give a good description of the body as whole (Josephine, Martin, Alfa, Czary, Jon, Albert and Lou, 2011). Jones, Olds, and Carter, (2006) defined anthropometry as the study of the measurement of the human body in terms of the dimensions of bone, muscle and adipose (fat) tissue.

Basal metabolism is the energy expended in the cellular processes necessary to the maintenance of life.The basal metabolic rate (BMR) is measured in Calories and is primarily accounted for by the activity of the brain, heart, liver, and kidneys. The Harris-Benedict equations are commonly used for calculation of the BMR in adults. The Basal metabolic rate (BMR) is influenced by different factors such as hormonal and body composition changes, which are features found in obesity and type2 diabetes mellitus. In sedentary individuals, the BMR is about 60 to 70% of Total Estimated Energy(Ravussin and Swinburn,1992), and a small change can lead to an energy imbalance and changes in Body Mass (Huang, Kormas, Steinbeck, Loughnan, and Caterson, 2004).The use of prediction equations is the fastest, simplest, and cheapest way to estimate BMR, taking into consideration factors such as gender, age, mass, height, and lean body mass. However, several authors have shown that these equations can generate errors that overestimate or underestimate the result, without, however, clarifying the magnitude of these errors (Frankenfield, Roth-Yousey, and Compher, 2005). The primary objective of the study is the assessment of the anthropometry and selected body composition of female undergraduates as predictor of basal metabolic index.

Methodology

Population and Sample

The population for this study comprises the female students of Medicine and Health Sciences College of Afe Babalola University. Total sampling technique was used to draw sample from the population. A total of 110 female students voluntarily participated in the study.

Procedure for Data Collection

The quasi-experimental design was adopted for the study. The instrument used for data collection were digital sphygmomanometer, stopwatch, whistle, training bib, and marker. All the instruments were validated before the experimental procedure and reliability checked. The selected body composition parameters considered for the study wereBody Mass Index (BMI), Waist Circumference (WC), Hip Circumference (HC), Waist to Hip ratio (WHR), Waist to Height Ratio (WHtR) and Basal Metabolic Rate (BMR). Data obtained from 1.5mile run were used to derive maximum oxygen uptake results.

Waist circumference (WC) was estimated halfway between the costal edge and the iliac crest on the side and between the processusxyphoideus and umbilicus in the front (Tran &Weltman 1989). Hip circumference (HC) was taken at the greatest circumference around the buttocks (Lohman 1981). Circumferences were measured twice with a flexible inextensible tape to a 0.1 cm accuracy and the mean was used. The waist-to-hip circumference ratio (WHR) wassimply calculated by dividing the waist with the hip circumference (Heyward &Stolarczyk 1996). A cut-off point of 80 cm for WC was used for identifying individuals with moderate health risk and a critical value of 88 cm or more for individuals with high risk for cardiometabolic disorders linked to central obesity distribution type.

Waist hip ratio was obtained by dividing the waist circumference by hip circumference. The participants with WHR 0.80-0.84 were classified as overweight and with WHR > 0.85 were classified as obese (World Health Organization, 1998). To obtain waist to height ratio, waist was divided height.The following regression equation was used to calculate the Basal Metabolic Rate (BMR): BMR = 655 + (4.35 x weight in pounds) + (4.7 x height in inches) - (4.7 x age) (Harris and Benedict, 1919)

Procedure for Data Analysis

The Statistical Package for the Social Sciences (SPSS; version 17.0) was used for the data analysis. The descriptive statistics of mean, standard deviation, standard error of mean, frequency and percentage counts were calculated for of age, height, BMI, WC, HC, WHR, WHtR and BMR, while inferential statistics of Pearson product moment correlation coefficient and regression analysis were used to determine the level of relationship that exists among the variables and the predictors of BMR. Statistical significance was set at 0.05 alpha level.

Hypotheses

1. Age will not be a significant predictor of BMR of female undergraduates.
2. Height will not be a significant predictor of BMR of female undergraduates.
3. Weight will not be a significant predictor of BMR of female undergraduates.
4. Body mass index will not be a significant predictor of BMR of female undergraduates.
5. Waist circumference will not be a significant predictor of BMR of female undergraduates.

6. Hip circumference will not be a significant predictor of BMR of female undergraduates.
7. Waist to hip ratio will not be a significant predictor of BMR of female undergraduates.
8. Waist to height ratio will not be a significant predictor of BMR of female undergraduates.

Results

Table 1 on the summary of descriptive statistics of variables

	N	Mean	Std. Error of Mean	Std. Deviation	Minimum	Maximum
AG	111	18.45	.122	1.282	16	23
HEIGHT(cm)	110	163.51	.623	6.533	153	183
WEIGHT(kg)	110	61.08	.978	10.262	42	98
BMI(kg/m^2)	110	22.85	.365	3.830	16	38
WC(cm)	110	30.55	.352	3.696	24	45
HC(cm)	110	38.52	.308	3.228	33	48
WHR	110	.7937	.00693	.07271	.65	1.19
WHtR	110	.1872	.00230	.02415	.14	.28
BMR(kcal)	111	1449.0082	9.67049	101.42491	1243.20	1794.50

Kg means Kilogram, m^2 means meter square, cm means centimeter, kcal means kilocalories, ag means age, bmi means body mass index, wc means waist circumference, hc means hip circumference, whr means waist to hip ratio, whtr means waist to height ratio and bmr means basal metabolic rate

Table 2 on Frequency distribution of Body Mass Index values compared with normative values

bminorm

	Frequency	Percent	Valid Percent	Cumulative Percent
Underweight	14	12.6	12.7	12.7
Normal	65	58.6	59.1	71.8
Overweight	28	25.2	25.5	97.3
Obese	3	2.7	2.7	100.0
Total	110	99.1	100.0	

Table 3 on Frequency distribution of waist circumference compared with normative values

wcnorm

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Normal	97	87.4	88.2	88.2
	High	13	11.7	11.8	100.0
	Total	110	99.1	100.0	
Missing	System	1	.9		
Total		111	100.0		

Table 4 on Frequency distribution of WHR compared with normative values

WHRnorm

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low	66	59.5	60.0	60.0
	Moderate	25	22.5	22.7	82.7
	High	19	17.1	17.3	100.0
	Total	110	99.1	100.0	
Missing	System	1	.9		
Total		111	100.0		

Table 4 on the correlational matrix of body composition parameters

Correlations

	bmi	wc	hc	whipr	BMR
BMI	1	.642** .000	.619** .000	.263** .006	.841** .000
WC	.642** .000	1	.649** .000	.713** .000	.583** .000
HC	.619** .000	.649** .000	1	-.067 .488	.608** .000
WHR	.263** .006	.713** .000	-.067 .488	1	.200* .036
BMR	.841** .000	.583** .000	.608** .000	.200* .036	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 5 on the Regression analysis for the study

	predictor	**dependent**	**β**	**F**	**R**	**R Square**	**Sig**	**Remarks**
1	Age	BMR	.046	.234	.046	.002	.630	NS
2	height	BMR	.328	13.027	.328	.108	.000	SIG
3	weight	BMR	.993	7900.606	.993	.987	.000	SIG
4	BMI	BMR	.841	260.529	.841	.707	.000	SIG
5	WC	BMR	.583	55.715	.583	.340	.000	SIG
6	HC	BMR	.608	63.179	.608	.369	.000	SIG
7	WHR	BMR	.200	4.518	.200	.040	.036	NS
8	WHTr	BMR	.448	27.055	.448	.200	.000	SIG

Discussion

Table I showed the descriptive statistics of the variables considered for the study, which are age, height, weight, body mass index (BMI), waist circumference (WC), hip circumference (HC), waist to hip ratio

(WHR), waist to height ratio (WHtR)and basal metabolic rate. Age mean was 18.45 (SD=1.28; SEM=.122); height mean was 163.51 (SD=6.53; SEM=.623); weight mean was 61.08 (SD=10.26; SEM=.978); BMI mean was 22.85 (SD=3.83; SEM=.365); WC mean was 30.55 (SD=3.696;SEM=.352); HC mean was 38.52 (SD=3.23;SEM=.308); WHR mean was .7937 (SD=3.696;SEM=.352); WHtR mean was .1872 (SD=.02415;SEM=.00230) and BMR mean was 1449.0082 (SD=101.42491;SEM=9.67049). Table 2 on the frequency distribution of body mass index values compared with the body mass index normative values showed that more than 58.6% of the participants used in the study had normal BMI while 25.2% were overweight, which means that more than half of the female students had normal BMI. This result is in variance with a study carried out by Jafar, Hasan, Bassam and Tasnim (2012) with 146 students whereby more than half of the students were above the normal body weight. Overweight students represented 22.6% of the sample whereas, 11.6% were obese.

Table 3 on the frequency distribution of waist circumference values compared with the waist circumference normative values showed that more than 87.4% of the participants used in the study had normal WC while 11.8% were had high WC. Table 4 on the frequency distribution of waist circumference values compared with the waist circumference normative values showed that more than 87.4% of the participants used in the study had normal WC while 11.8% had high WC.This result is consistent with the findings of Josephine, Martin, Alfa, Czary, Jon, Albert and Lou, (2011) carried out with 397 freshmen students which revealed that the percentage of normal BMI value of 62.50% and low risk WC values of 95.16% among male and 88.63% among female posed a relatively good health status among the freshmen students.The pearson product moment correlation coefficient results showed strong positive relationship between BMI and WC (r=.642), BMI and HC (.619), WC and HC (.649), WC and WHR (.713), BMI and BMR (.841), HC and BMR (.608), BMR and WC (.583).Janssen et al. (2002) showed that combination of BMI and WC can better predict metabolic risk than does either variable alone. Anthropometric measurements such as waist circumference (WC) and waist-to-hip circumference ratio (WHR) are strongly correlated with the quantity of visceral fat, so they are reliable predictive factors for central obesity-related diseases (Kravos 2005; Evans et al. 2012).

The linear regression analysis result in table 5 (β =.046, $F_{(1,108),}$ =.234, p=.630) revealed that age had a low positive relationship with BMR (r=.046) and accounted for 2% variance in BMR (r^2 = .002). Therefore age was not a significant predictor of BMR. The result for height (β =.328, $F_{(1,108)}$=13.027, p=.000) revealed that age had a low positive relationship with BMR (r=.328) and accounted for 10.8% variance in BMR (r^2 = .108). Therefore height was a significant predictor of BMR. This result was inconsistent with Schofield (1985) which found out that the correlations for height alone were r (4809)= 0.87 and r (2364) = 0.886 for similar numbers of males and females respectively. It is important to point out that the relationships are not perfect and the high correlations obtained with height are largely the result of the contributions of large numbers in the database.

The result for weight (β =.993, $F_{(1,108)}$=7900.606, p=.000) revealed that age had a strong positive relationship with BMR (r=.993) and accounted for 98.7% variance in BMR (r^2 = .987). Therefore weight was a significant predictor of BMR. This result showed a stronger coefficient of determination than the study carried out by Soares& Shetty (1988) which found out that the multiple linear regressions using BMR as the dependent variable were as follows: weight alone, multiple r = 0.80 (r2 = 0.64); weight + age, multiple r = 0.81 (r2 = 0.65); weight + BMI + age, multiple r = 0.81 (r2 = 0.65). The addition of other variables makes hardly any difference to the strong correlations that body weight has with BMR**.**Comparison of the correlation coefficients obtained by both Schofield and by Soares& Shetty (1988) shows that BMR has a stronger correlation with body weight than with any other nutritional anthropometric index used as a single independent variable.

The result for BMI (β =.841, $F_{(1,108)}$=260.529, p=.000) revealed that age had a strong positive relationship with BMR (r=.841) and accounted for 70.7% variance in BMR (r^2 = .707). Therefore BMI was a significant predictor of BMR. The analysis by Soares& Shetty (1988) demonstrated an r = 0.80 for body weight accounting for 64% of the variance while BMI had an r = 0.64 and height an r = 0.57, thus explaining only 41% and 33% of the variance respectively. This association between BMI and BMR, seen in both well-nourished adults and those with low BMIs in developing countries, has also been reported in well-nourished populations and those with increasing degrees of obesity in the West (Garrow *et al.,* 1988).However, since BMI has approximately the same value for short, medium height and tall individuals, being independent of stature (Khosla & Lowe, 1967), the index simplifies the approach to estimating the acceptable or optimum body weight for that height among groups of different heights in a population

The result for WC (β =.583, $F_{(1,108)}$=55.715, p=.000) revealed that age had a moderate positive relationship with BMR (r=.583) and accounted for 34% variance in BMR (r^2 = .340). Therefore WC was a significant predictor of BMR. The result for HC (β =.608, $F_{(1,108)}$=63.179, p=.000) revealed that age had a low positive relationship with BMR (r=.608) and accounted for 36.9% variance in BMR (r^2 = .369). Therefore HC was a significant predictor of BMR. The result for WHR (β =.200, $F_{(1,108)}$=4.518, p=.000) revealed that age had a low positive relationship with BMR (r=.200) and accounted for 4% variance in BMR (r^2 = .040). Therefore WHR was not significant predictor of BMR.The result for WHtR (β =.448, $F_{(1,108)}$=27.055, p=.000) revealed that age had a low positive relationship with BMR (r=.448) and accounted for 20% variance in BMR (r^2 = .200). Therefore WHtR was a significant predictor of BMR. Few studies have sought to compare the improvement in the estimation of BMR with the addition of simple anthropometric measures to those obtained from more complex 'gold-standard' laboratory-based techniques. One such study involved a multiple regression equation, using the predictors of mass, height and age and gave a correlation of 0.841 with BMR and the SEE was 521 kJ/day (Van der Ploeg et al., 2001).

Conclusion

In conclusion, the result of the findings showed that the female students who participated in the study have healthy body composition on the average which may be accounted for the significant prediction of basal metabolic rate by all the variables except for age and waist to hip ratio. According to Shetty and James (1994), BMR, and consequently total energy expenditure, can be predicted from the derived optimum body weight, and thus BMI may be a useful addition in arriving at desirable levels of energy requirements of individuals or populations.

Reference

Evans, P. D., Natasha J. McIntyre, Richard J. Fluck, Christopher W. M & Maarten W. Tall. (2012). Anthropometric measurements that include central fat distribution are more closely related with key risk factors than BMI in CKD Stage 3. . *Plos one* , 7(4).

Frankenfield, D. Roth-Yousey, L.and Compher. C. (2005). "Comparison of predictive equations for resting metabolic rate in healthy nonobese and obese adults: a systematic review," . *Journal of the American Dietetic Association,*, vol. 105, no. 5, pp. 775–789.

Garrow JS, Blaza SA, Warwick PM & Ashwell MA. (1988). Predisposition to obesity. . *Lancet i*, 1103-1104.

Gurpreet K, K. B. (2012). Body Composition, Dietary Intake and Physical Activity Level of Sedentary Adult Indian Women. . *Food and Nutrition Sciences*, 3, 1577-1585, http://dx.doi.org/10.4236/fns.2012.311206.

Harris J, Benedict, F. . (1919). *A biometric study of basal metabolism in man.* Washington, DC: : Carnegie Institution Publication 279.

Heyward Vivian H. & Lisa M. Stolarczyk. . (1996.). Body composition methodology. . *In: Richard Washburn (ed.), Applied body composition assessment. Champaing: Human Kinetics,* , pp. 1–20.

Huang, K.C., Kormas, N., Steinbeck, K., Loughnan, G., and Caterson. I. D. (2004). "Resting metabolic rate in severely obese diabetic and nondiabetic subjects,". *Obesity Research*, vol. 12, no. 5, pp. 840–845.

Jafar M. E, Hasan A, Bassam A and Tasnim O. I. (2012). Nutritional Status among a Sample of Saudi College Students . *Current Research Journal of Biological Sciences*, 4(5): 557-562.

Janssen I, Heymsfield S, Allison D, Kotler D, Ross R. . (2002). Body Mass Index and Waist Circumference Independently Contribute to the Prediction of Non-abdominal. Abdominal Subcutaneous, and Visceral Fat . *Am J Clin Nutr.* , 75: 683-8.

Jones M, Olds TS, and Carter JE. (2006.). *International Standards for Anthropometric Assessment* . ISAK,.

Josephine B. R , Martin L A , Alfa C, Czary G , Jon M G , Albert N and Lou A S . (2011).) Health Risks Determinants among Freshmen Students of the University of Santo Tomas. . *International Journal of Sports Science and Engineering* , Vol. 05 (2011) No. 01, pp 058-064.

Khosla T & Lowe CR. (1967). Indices of obesity derived from body weight and height. *Br. J. Prev. Soc. Med.*, 21, 122-136.

Lohman, T. G. (1981). Skinfolds and body density and their relation to body fatness: a review. . *Human Biology* , 53: 181–225.

Ravussin E. and Swinburn, B. A. (1992). "Pathophysiology of obesity," . *The Lancet,* , vol. 340, no. 8816, pp. 404–408,.

Schofield WN, Schofield C & James WPT. (1985). Basal metabolic rate - review and prediction together with annotated bibliography of source material. . *Hum. Nutr: Clin. Nutr* , 39C, Suppl. 1, 5-96.

Soares MJ & Shetty PS . (1988). Validity of Schofield's predictive equations for basal metabolic rates of Indians. . *Ind. J. Med. Res.*, S%, 253-260.

Tran, Zung Vu & Arthur Weltman. 1989. (1989). Generalized equations for predicting body density of women from girth measurements. . *Medicine and Science in Sports and Exercise* , 21(1): 101–4.

Van der Ploeg GE, Gunn SM, Withers RT, Modra AC, Keeves JP, Chatterton BE. (2001). Predicting the resting metabolic rate of young Australian males. . *Eur J Clin Nutr* , 55, 145–152.

World. Health. Organization, (1998). *Obesity preventing and managing the Global Epidemic: Report of a WHO cosultation on obesity.* Geneva: World Health Organization .