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ESTIMATION OF BODY COMPOSITION PARAMETERS FROM WEIGHT, BMI AND SUM OF SKIN FOLD OF WOMEN FROM KADUNA AND RIVERS STATES OF NIGERIA

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ABSTRACT

Aim: This study was intended to estimate body composition parameters from weight, BMI and sum of skinfold of women from Kaduna and Rivers states of Nigeria. **Materials and methods:** A total of 788 (Rivers state, n=401 and Kaduna, n=387) apparently healthy females participated in this study. Weight and height was measured using stadiometer. Body mass index (BMI) was calculated as weight (kg)/height (m^2) and categorized according to ferro-Luzzi*et al*. (1992).Skinfold calliper was used to measure the iliac and biceps skinfold thickness. Body composition parameters (muscle mass, total body water, percentage body fat, bone mass, physique rating, visceral fat rating, basal metabolic rate, metabolic age) were measured using bio impedance analyser (Tanita, Japan). A correlation test and linear regression test was used to analyse results using SPSS version 18. **Results:** This study showed that weight, BMI, biceps and iliac skinfold correlated positive with all body composition parameters except for total body water and physique rating which showed negative correlation. The mean Basal metabolic rate (BMR) was 2074± 158.89 and 2136.48 ± 201.86 for Kaduna women and Rivers women respectively. **Conclusion**: In Kaduna women, weight can be used to predict all body composition parameters except bone mass, BMI can be used to predict all body composition parameters exceptbone mass and physique rating, sum of skinfold can also be used to predict body composition parameters except for bone mass, muscle mass and BMR. In Rivers women, weight can be used to predict body composition parameters, BMI can also be used to predict body composition parameters except for total body water, sum of skinfold can also be used to predict body composition parameters except for bone mass.

KEYWORDS: Basal metabolic rate, bioimepedance analyser, Bone mass.

INTRODUCTION

The term Body Composition can be defined as the amount of lean tissue compared to fat (Amir and Rakhshanda, 2009). Studies on human body composition has formed a central part of medical research, whose goal has been accurate assessment of body fat (Ackland et al., 2012). A two component model of body composition divides the body into fat component and fat free component is used to illustrate the different components that, when taken together, makes up a person's body weight (Amir and Rakhshanda, 2009). Body composition data can make the basis for a wide variety of therapeutic, health and fitness programs, that is, clinically, body composition analysis provides the foundation upon which further treatment is based (Amir and Rakhshanda, 2009).

Measurement of body composition can be moreaccurately assessed and the effects of both dietary andphysical activity programs better directed. Percentage body fat is variable, but has a relatively constant densityof about 900Kg/m^3 at 37°C (Allen *et al*., 1959) and anegligible water and potassium content. The fat freemass of an individual consists of three components: total body protein,total body water and bone minerals, with densities at 37°C of approximately 993, 1304 and 3000kg/m^3respectively. Fat free mass also known as muscle mass, has arelatively constant composition in healthy persons, with water content of 72% to 74% (Sheng and Huggins, 1979) potassium content of about 60-70mmol/Kg in men and 50-60mmol/Kg in women (Womersley *et al*., 1976) and aprotein content of about 20% (Garrow, 1982). Evaluation of body composition has become animportant aspect of adult fitness and medical rehabilitation programmes; the major goal is to control body weight and fat with regular exercise and nutrition.

In situations where actual measures are not feasible, Basal Metabolic Rate (**BMR)**can be predicted from recommended equations. These equations are based on body weight and are age- and sex specific (FAO/WHO/UNU, 1985; Schofield *et al.* 1985). The adoption of the FAO/WHO/UNU (1985) report for purposes of estimating energy requirements has hence brought into focus the accuracy of **BMR** measurement, its physiological variability and the validity of its prediction in population groups worldwide.

Researchers have derived regression equations that estimate the various body compositions, muscle mass, body fat percentage, total body water and visceral fat, but these equations are population specific (Ojoawu *et al*., 2013). Therefore, the use of these equations can only produce accurate results if subjects are drawn from populations similar to the population from which the equations were originally derived.

The aim of the present study is to determine if BMI, weight, sum of skinfold (triceps and iliac) thickness can be used as predictors of body composition parameters in Kaduna and Rivers women.

MATERIALS AND METHODS

Subjects

Seven hundred and eighty eight (788) apparently healthy female subjects participated in this study. The participants were students some tertiary institutions in Kaduna and Rivers state. The inclusion criteria for the study included female indigenes of Kaduna and Rivers state within the age range of 18-30 years, which were apparently healthy and without any physical deformity. The study was approved by the Ahmadu Bello University Ethical clearance committee

Anthropometric measurements

The anthropometric measurements included body weight, height. Subjects were weighed in minimal clothing using a stadiometer to the nearest 0.1kg. Height was measured using a vertically mounted stadiometer to the nearest 0.1cm. Body mass index (BMI) was calculated from the height and weight as follows; BMI = weight (kg)/height2 (m).

Skinfold measurement was carried out on the subjects in triplicate in the standing position and themean of each taken for further calculation: triceps and suprailiac. The skinfoldmeasurements (triceps and iliac) were carried out to the nearest 0.1 mm using skinfold calipers.

Bioimpendence analyser (BIA) measures the body composition of various body segments and is influenced by a number of effects (hydration, fat fraction, geometrical boundary conditions, etc.). Data from both hypo- and hyper-hydration studies suggest that electrolyte balance influences BIA measurements independently of fluid changes. Such effects may be difficult to predict, as fluid and electrolyte changes will also affect the ratio of intra- to extracellular water which, in turn, influences resistivity.

Body composition parameters (muscle mass, total body water, percentage body fat, bone mass, physique rating, visceral fat rating, basal metabolic rate, metabolic age) were measured using bio impedance analyser (Tanita, Japan). A correlation test and linear regression test was used to analyse results using SPSS version 18.

RESULTS

In Kaduna women, the correlation coefficient of weight, BMI andbody composition parameters (muscle mass, total body water, percentage body fat, physique rating, visceral fat ratings, basal metabolic rate) was observed to be significant and positive except for total body waterand physique rating which showed negative correlation, indicating a strong relationship weight, BMI and body composition parameters.

Linear regression equation for body composition parameter estimations were constructed using weight, BMI and sum of skinfold. The highest correlation coefficient between % BF, MM and weight provides the highest reliability and accuracy in estimating body composition parameters among Kaduna women.

In Kaduna women, weight correlated significantly ($p<0.001$) and positively with all studied body composition parameters except for total body water and physique rating which correlated negatively with weight. BMI also correlated significantly ($p<0.001$) and positively with all studied body composition parametersexcept for total body water and physique rating which correlated negatively with BMI, and arm circumference which was significant at $p<0.05$. No significant correlation was observed between BMI and Bone mass (Table 1).

In Rivers women, weight correlated significantly ($p<0.000$) and positively with all studied body composition parameters except for TBW and PR which correlated negatively with weight. BMI also correlated significantly ($p<0.000$) and positively with all studied body composition parameters except for total body water and physique rating which correlated negatively with BMI and hip circumference which was significant at $p<0.05$ (Table 2).

Linear regression was used to relate body composition parameters topotential predictor variables such as weight, BMI, and sum of skinfold. Body composition parameters significantly related to weight, BMI and sum of skinfold in study subjects, except for sum of skinfold that did not correlate significantly with daily calorie intake in Kaduna women (Table 3 and 4). These population specificequations were then tested, used togenerate the respective equation.

WT can be used to predict all body composition parameters in Kaduna women except for bone mass and muscle mass, BMI can be used to predict all body composition parameters in Kaduna women except for BM and physique rating, also sum of skinfold can be used to predict all body composition parameters in Kaduna women except for bone masscan be used to predict all body composition parameters in Kaduna women except for BMR (Table 3 and 4).

Table 1: Descriptive statistics of Body composition parameters.

Variables	Kaduna (n=387) Mean± SD	Maximum	Minimum	Rivers (n=401) Mean ± SD	Maximum	Minimum	t	p
Body Fat Percentage (%)	25.41 ± 41	44.60	5.00	26.57 ± 7.56	49.30	5.00	2.19	0.03
Basal Metabolic Rate (kcal)	2074.87±158.89	2651.00	1648.00	2136.48±201.86	2974.00	1008.00	4.75	<0.001
Muscle Mass (kg)	40.56 ± 3.12	55.20	31.90	41.87 ± 4.47	64.70	64.70	4.73	<0.001
Physique Rating	5.31 ± 2.00	9.00	1.00	5.10 ± 1.94	9.00	9.00	1.53	0.13
Total Body Water (%)	51.99 ± 4.78	73.60	33.30	51.34 ± 5.47	75.80	75.80	1.77	0.08
Visceral Fat Rating	1.96 ± 1.54	9.00	1.00	2.20 ± 1.87	13.00	13.00	1.94	0.05

Table 1: Correlation between anthropometric and body composition parameters in Kaduna women.

	WT	HT	BMI	TSF	ISF	%BF	TBW	VFR	MM	PR	BMR	MtA
WT	-	0.34^{d}	0.90^{d}	0.61^{d}	0.61^{d}	0.87^{d}	-0.84^{d}	0.81^{d}	0.90^{d}	-0.71^{d}	0.90^{d}	0.87^{d}
HT		-	-0.01^{a}	-0.06	-0.09	0.15^{b}	-0.13^{a}	0.05	0.47^{d}	-0.17^{d}	0.45^{d}	0.16^{b}
BMI			-	0.68^{d}	0.68^{d}	0.85^{d}	-0.82^{d}	0.84^{b}	0.63^{d}	-0.67^{d}	0.74^{d}	0.84^{d}
TSF				-	0.83^{d}	0.68^{d}	-0.66^{d}	0.63^{b}	0.40^{d}	-0.56^{d}	0.48^{d}	0.65^{d}
ISF					-	0.68^{d}	-0.69^{d}	0.63^{b}	0.38^{d}	-0.56^{d}	0.48^{d}	0.66^{d}
%BF						-	-0.96^{d}	0.81^{b}	0.55^{d}	-0.80^{d}	0.69^{d}	0.89^{d}
TBW							-	-0.79^{d}	-0.51^{d}	0.79^{d}	-0.64^{d}	-0.87^{d}
VFR								-	0.54^{d}	-0.65^{d}	0.65^{d}	0.93^{d}
MM									-	-0.45^{a}	0.95^{d}	0.60^{d}
PR										-	-0.56^{d}	-0.74^{d}
BMR											-	0.71^{d}
MtA												-

n=387, a=p<0.05, b=p<0.01, c=p<0.001, d=p=0.000.
WT=Weight; HT=Height; BMI=Body Mass Index; TSF= Triceps Skinfold; ISF= Iliac Skinfold; W/H= Waist Hip Ratio; %BF=Percentage Body Fat; TBW= Total Body Water; VFR= Visceral fat Rating; MM=Muscle Mass; BM= Bone Mass; BMR = Basal metabolic rate; MtA= Metabolic Age, PR=Physique rating.

Table 2: Correlation between anthropometric and body composition parameters in Rivers women.

	WT	HT	BMI	TSF	ISF	%BF	TBW	VFR	MM	PR	BM	BMR	MtA
WT	-	0.21^{d}	0.93^{d}	0.62^{d}	0.63^{d}	0.79^{d}	-0.68^{b}	0.74^{d}	0.54^{d}	-0.57^{d}	0.36^{d}	0.72^{d}	0.79^{b}
HT		-	-0.17^{d}	-0.03	0.03	0.15	-0.08	0.04	0.33^{d}	-0.17^{d}	0.25^{d}	0.39^{d}	0.14^{b}
BMI			-	0.65^{d}	0.63^{d}	0.75^{d}	-0.66^{d}	0.74^{d}	0.42^{d}	-0.51^{d}	0.27^{d}	0.58^{d}	0.75^{d}
TSF				-	0.85^{d}	0.71^{d}	-0.62^{d}	0.70^{d}	0.38^{d}	-0.53^{d}	0.23^{d}	0.53^{d}	0.70^{d}
ISF					-	0.69^{d}	-0.63^{d}	0.64^{d}	0.40^{d}	-0.51^{d}	0.21^{d}	0.54^{d}	0.67^{d}
%BF						-	-0.88^{b}	0.81^{d}	0.40^{d}	-0.77^{d}	0.25^{d}	0.63^{d}	0.89^{d}
TBW							-	-0.71^{d}	-0.31^{d}	0.65^{d}	-0.20^{d}	-0.51^{d}	-0.78^{d}
VFR								-	0.46^{d}	-0.56^{d}	0.30	0.62^{d}	0.87^{d}
MM									-	-0.31^{d}	0.42^{b}	0.72^{d}	0.44^{d}
PR										-	-0.14	-0.40^{d}	-0.68^{d}
BM											-	0.49^{d}	0.29^{d}
BMR												-	0.63^{d}
MtA													

n=401, a=p<0.05, b=p<0.01, c=p<0.001, d=p=0.000
WT=Weight; HT=Height; BMI=Body Mass Index; TSF= Triceps Skinfold; ISF= Iliac Skinfold; W/H= Waist Hip Ratio; %BF=Percentage Body Fat; TBW= Total Body Water; VFR= Visceral fat Rating; MM=Muscle Mass; BM= Bone Mass; BMR = Basal metabolic rate; MtA= Metabolic Age, PR=Physique rating.

Table 3: Linear Regression of Body composition parameters from weight, BMI and sum of skinfold studied in Kaduna women.

Parameters	Predictive equation	P value	
%BF	WT	%BF = (-12.704) + 0.422 * WT	0.000
	BMI	%BF = (-12.704) + 0.418 * BMI	0.000
	SSF	%BF = (-12.704) + 0.167 * SSF	0.000
TBW	WT	TBW = (75.778) + (-0.246) * WT	0.000
	BMI	TBW = (75.778) + (-0.294) * BMI	0.002
	SSF	TBW= 77.778 + (-0.114) * SSF	0.000
Muscle mass (Kg)	WT	MM= 26.608 + 0.397 * WT	0.000
	BMI	MM= 26.608 + (-0.365) * BMI	0.000
	SSF	MM= 26.608 + (-0.027) SSF	0.049
Physique rating	WT	PR=13.469 + (-0.117) * WT	0.000
	BMI	PR= 13.469 + (-0.017) * BMI	0.721
	SSF	PR= 13.469 + (-0.042) * SSF	0.000
Visceral fat rating	WT	VFR= (-5.963) + 0.052 * WT	0.000
	BMI	VFR= (-5.963) + 0.191 * BMI	0.000
	SSF	VFR = (-5.963) + 0.022 * SSF	0.001
Basal metabolic rate (Kcal)	WT	BMR= 1271.628 + (19.820)* WT	0.000
	BMI	BMR= 1271.628 + (14.321) *BMI	0.000
	SSF	BMR= 1271.628 + (-0.639)* SSF	0.220

%BF=Percentage Body Fat; TBW= Total Body Water; VFR= Visceral fat Rating; MM=Muscle Mass; BM= Bone Mass; BMR = basal metabolic rate; MtA= Metabolic Age, PR=Physique rating, BMI= body mass index, SSF= sum of skinfold, WT=weight.

Table 4: Linear Regression of Body composition parameters from weight, BMI and sum of skinfold studied in Rivers women.

Parameters	Predictive equation		P value
TBW	WT	TBW = 69.44 + (-0.184) * WT	0.000
	BMI	TBW = 69.44 + (-0.078) * BMI	0.497
	SSF	TBW= 69.44 + (-0.202) * SSF	0.000
Bone mass (Kg)	WT	BM = 1.697 + 0.022 * WT	0.000
	BMI	BM= 1.697 + (-0.036) *BMI	0.000
	SSF	BM= 1.697 + 0.002 * SSF	0.490
Muscle mass (Kg)	WT	MM= 31.196 + 0.388 * WT	0.000
	BMI	MM= 31.196 + (-0.638) * BMI	0.000
	SSF	MM= 31.196 + 0.074 *SSF	0.004
Physique rating	WT	PR=10.112+ (-0.098) * WT	0.000
	BMI	PR= 10.112 + (0.116) * BMI	0.015
	SSF	PR= 10.112 + (-0.067) * SSF	0.000
Visceral fat rating	WT	VFR= (-4.707) + 0.048 * WT	0.000
	BMI	VFR= (-4.707) + 0.098 * BMI	0.005
	SSF	VFR = (-4.707) + 0.068 * SSF	0.000
Basal metabolic rate (Kcal)	WT	BMR= 1488.534 + 20.610 * WT	0.000
	BMI	BMR= 1488.534 + (-31.471) *BMI	0.000
	SSF	BMR= 1488.534 + 4.922 * SSF	0.000
Metabolic age (yrs)	WT	MA= (-25.835) + 0.681 * WT	0.000
	BMI	MA= (-25.835) + (-0.169) * BMI	0.001
	SSF	MA= (-25.835) + 0.464 * SSF	0.000

%BF=Percentage Body Fat; TBW= Total Body Water; VFR= Visceral fat Rating; MM=Muscle Mass; BM= Bone Mass; BMR = basal metabolic rate; MtA= Metabolic Age, PR=Physique rating, BMI= body mass index, SSF= sum of skinfold, WT=weight.

DISCUSSION

The estimation of body composition parameters could be made using the weight, BMI, iliac and triceps skinfold, but the prediction equations established are population specific.

The findings of the present study indicates that the correlation coefficient r between body composition parameters and weight were significant for % BF, TBW, MM, PR, and BMR in both Kaduna and Rivers states women, with the highest correlation r between the dependent variable (MM and BMR) and independent variable (weight) was 0.90 (P < 0.000) for Kaduna state women and the least was indicated by (PR), r = -0.71. In Rivers women, the highest correlation r between % BF and independent variable (weight) was 0.79 (P < 0.000) while the least correlation was indicated by (MM), r = 0.54.This was in agreement with Jelena et al., 2016 and Vuvor and Harrison (2017) who reported a correlation between % BF and weight.

This study revealed that the correlation r between the dependent variable (% BF, TBW, MM, PR, and BMR) and independent variable (BMI) was significant for both Kaduna and Rivers states women. The highest correlation r for Kaduna women, between the dependent variable (% BF) and independent variable (BMI) was 0.85 (P < 0.000) while the least was r = 0.63 as seen in MM. In Rivers women, the highest correlation r between the dependent variables and independent variable (BMI) was seen in % BF, r = 0.75 (P < 0.000) while the least was r = 0.42 as seen in MM. This was in agreement with Akindele et al., (2016) who reported a strong and positive relationship between BMI and BF%.

This present study shows the correlation between the independent variable (TSF) and the dependent variable (% BF, TBW, MM, PR, and BMR) was significant for both Kaduna and Rivers states women. The highest correlation r for Kaduna women, between the dependent variable (% BF) and independent variable (TSF) was 0.68 (P < 0.000) while the least correlation was indicated by (MM), r = 0.40. In Rivers women, the highest correlation r between the dependent variables and explanatory variable (TSF) was seen in % BF, r = 0.71 (P < 0.000) while the least was r = 0.38 as seen in MM. Pongchaiyakul et al., (2005) suggest that simple, noninvasive, and inexpensive anthropometric variables may provide an accurate estimate of %BF.

In Kaduna and Rivers women, the study revealed that the correlation coefficient r between the dependent variable and the explanatory variable (ISF) of the body composition parameters (% BF, TBW, MM, PR, and BMR) was significant. Among the Kaduna women, the highest correlation between the dependent variable and the explanatory variable (ISF) of the body composition parameters was seen in TBW, r = -0.69 while the least correlation was indicated by (MM), r = 0.38. In Rivers women, the highest correlation r between the dependent variables and explanatory variable (ISF) was seen in % BF, r = 0.69 (P < 0.000) while the least was r = 0.40 as seen in MM.

CONCLUSION

Linear regression equations were derived from the present data from weight, BMI, and sum of skinfold. It is hoped that these equations will be used to estimate body composition parameters in Kaduna and Rivers women.

REFERENCES

1. Ackland TR, Lohman TG, Sundgot-Borgen J, Maughan RJ, Meyer NL, Stewart AD, Muller W. Current status of body composition assessment in sport review and position statement on behalf of the ad hoc research working group on body composition health and performance, under the auspices of the I.O.C. Medical Commission. Sports Medicine, 2012; 42(3): 227–249.
2. Akindele, M. O; Phillips, J.S. and Igumbor, E. U. The Relationship Between Body Fat Percentage and Body Mass Index in Overweight and Obese Individuals in an Urban African Setting. J Public Health Africa, Aug 17, 2016; 7(1): 515.
3. Allen, T. H., Welch, B. E., Trujillo, T. T. & Roberts, J. E. Density, fat, water and solids in freshly isolated tissues. J. Appl. Physiol, 1959; 14: 1009–1012.
4. Amir, H. S. and Rakhshanda Bilal. Body Composition, its Significance and Models for Assessment. Pakistan Journal of Nutrition, 2009; 8(2): 198-202.
5. FAO/WHO/UNU. Energy and protein requirements, Technical report, 1985; 724 WHO: Geneva.
6. Ferro-Luzzi, A., S. Sette, M. Franklin and W. James, A simplified approach to assessing chronic energy deficiency. Eur. J. Clin. Nutr., 1992; 46: 173-186.
7. Garrow, J. S. New approaches to body composition. Am. J. Clin. Nutr., 1982; 35: 1152-1158.
8. Ojoawo, A.O., Onigbinde, T.A., Adeyanji, S. Skinfold as a predictor for body density of undergraduate female students in Nigeria University. *The Nigeria Health Journal*, 2013; 13.
9. Pongchaiyakul, C., Kosulwat, V., Rojroongwasinkul, N., Charoenkiatkul, S., Thepsuthammarat, K., Laopaiboon, M., Nguyen, T.V., Rajatanavin, R. Prediction of percentage body fat in rural thai population using simple anthropometric measurements. Obes Res., 2005; 4: 729-38.
10. Schofield, W. Predicting basal metabolic rate, new standards and review of previous work. *Clinical nutrition*, 1985; 39: 5-41.
11. Sheng, H.P. and R.A. Huggins, A review of body composition studies with emphasis on total body water and fat. Am. J. Clin. Nutr., 1979; 32: 630-647.
12. Womersley, J., J.V.G.A. Durnin, K. Boddy and M. Mahaffy, 1976.Influence of muscular development, obesity and age on the fat-free mass of adults. J. Applied Physiol., 41: 223-229. Womersley, J., J. V. G. A.; Durnin, K. Boddy, M. Mahaffy. Influence of muscular development, obesity, and age on the fat-free mass of adults. J. Appl. Physiol, 1976; 41: 223-229.