Niger. J. Physiol. Sci. 33(December 2018) 125-128
www.njps.com.ng

Niger. J. Physiol. Sci.

Short Communication

A Comparative Study of Different Body Fat Measuring Instruments

Omorede E. Osayande, Gloria N. Azekhumen and Emmanuel O. Obuzor

Department of Physiology, School of Basic Medical Sciences, College of Medical Sciences, University of Benin, Benin City, Nigeria.

Summary: There is an increase in the occurrence of obesity worldwide. The purpose of this study was to compare various convenient and affordable body fat measuring instruments in man to percentage body fat calculated using skinfold thickness to ascertain if they can be used as a substitute for more expensive` gold standard instruments used for measuring body fat. Seventy male students (20-30years) of the University of Benin where recruited in this study. Subjects were non-athletes without systemic disease, liposuction and not on routine medication. All measurements were taken between 7am and 10am daily. Subjects came fasting refrained from exercise 12 hours before the study and body weight (kg) was measured with a digital weighing scale. A standiometer, was used to measure height (m). BMI (kg/m^2) was calculated from weight and height. The Waist Circumference (WC) (cm) and Hip Circumference (HC) (m) of each subject were measured using a measuring tape. The Waist-Hip-Ratio (WHR) was calculated by dividing the subject's WC by the HC. Skinfold thickness (mm) of the chest, abdomen and thigh were taken with a calibrated Lange skinfold caliper. Body density (BD**)** values were calculated using the skinfold equation of Jackson and Pollock for men. Body fat percentage (%BF) was calculated from BD using the formula of Siri, with respect to the age of each individual. Results were presented as means ± S.E.M. Microcal origin 8.0 was used to analyze collected data and correlation studies were used to investigate the relationship between groups. *P* values less than 0.05 were considered statistically significant. BMI, WC, HC, skinfold thickness (abdomen, thigh and Chest), weight and estimated lean body mass were positively correlated with %BF in our study population while WHR and height were weakly and negatively correlated with %BF respectively. These alternative means of assessing body fat may be useful when more sophisticated methods are unavailable.

Keywords*:* Percentage Body fat percentage, Obesity, Skinfold thickness, Body Mass Index.

**Address for correspondence*:* omorede@uniben.edu; Tel: +2348034746210

Manuscript Accepted: July, 2018

INTRODUCTION

Obesity is an international health problem for children, adults, and the elderly (Popkin and Doak, 1998). It can lead to the development of type II diabetes, enhance risk factors for cardiovascular and related diseases, and is associated with increased cancer risk and renal failure. Childhood obesity foreshadows its persistence into and through adulthood (Guo *et al*., 2002) and obesity is becoming a common problem among the elderly (Seim and Holtmeier, 1993). Obesity is generally displayed as excess adipose tissue and a high body weight, but in some elderly persons and others with limited mobility it takes the form of sarcopenic obesity, in which a preferential loss of muscle tissue increases the percentage of body fat (Arterburn *et al*., 2004).

By 2025, it has been projected that approximately three billion people will be overweight worldwide; of these, 700 million will be obese. The assessment of obesity does not depend solely on the measurement of an individual's total body mass but also on body composition and fat distribution. Body composition can be measured by various techniques, including highly sophisticated and accurate methods like densitometry, plethysmography, underwater weighing, nuclear magnetic resonance and Dual-energy X-Ray Absorptiometry (DXA). However, these methods are complex and expensive, and their use in clinical practice and large epidemiological studies is limited (Horie *et al.*, 2008).

Measurements of body mass index (BMI), waist-hip ratio (WHR), waist circumference (WC) , and body composition assessments using skinfold thickness (ST) and bioelectrical impedance analysis (BIA) have been widely used due to their convenience and relatively low cost (Rezende *et al*., 2007).

BMI [BMI = weight (kg)/height (m)^2] has been the most widely used index for assessing weight status (WHO, 1995) due to its simplicity, ease of application, reduced demand for training and reliance on less expensive equipment.

The WC is a qualitative measurement of the central distribution of body fat and is considered a strong indicator of visceral fat, thereby predicting metabolic risks and potential chronic disease burden. Like WC,

WHR indicates the type of fat distribution and an individual's risk for developing disease (Huxley *et al*., 2010).

ST is a measure of body composition that allows the indirect estimation of body density and percent body fat (%BF) by means of equations. It is one of the most widely used assessment methods because it is easy to perform in daily practice, is cost effective, and is highly correlated with total body fat.

Few studies in the literature have assessed the ability of these methods to measure body fat among individuals, especially the overweight and obese persons. The assessment of body composition in these individuals can assist in identifying risks of co-morbidities and monitoring their evolution in clinical practice (Horie *et al*., 2008). It is also useful for research purposes.

It is important to know if these various convenient and affordable body composition techniques correlate well with body fat% so they can be used as a substitute for expensive gold standard instruments used for measuring body composition. The purpose of this study therefore was to compare different affordable body fat measuring instruments in man to body fat percentage calculated using the skinfold thickness.

MATERIALS AND METHODS

Subjects

Seventy male (70) students in the University of Benin aged between twenty (20) to thirty (30) years where recruited for this study questionnaires were used to rule out presence of any medical ailment, liposuction and use of routine medication subjects were not athletes. A signed informed consent was obtained from all subjects after explaining to them the objectives and procedures of the study.

Sampling

The study selection was based on the method of random selection sampling which was unbiased.

Procedures

All measurements were taken in the morning hours between 7am and 10am. Subjects were asked to come fasting and to refrain from exercise for at least 12 hours before the study (Chahar, 2014). The following measurements where then taken;

Measurement of Body Weight

The weight was measured with a digital weighing scale calibrated in kilograms and recorded for all subjects.

Measurement of Height

A standiometer, calibrated in meters was used. The measurement was done with subjects standing upright and bare footed.

Body Mass Index (BMI)

The Subjects' body weight in kilograms divided by the square of the height in metres was calculated to determine the BMI for each subject.

Waist Circumference (WC)

The WC (cm) of each subject was measured using a measuring tape.

The measurement was taken while standing tall with feet as close together as possible. It was measured directly against the skin and subjects were asked to breathe out normally. The tape was snug, without compressing the skin. It was measured halfway between the lowest rib and the top of the hipbone, roughly in line with the umbilicus. Multiple measurements were taken until they are within ¼ inch of each other. An average of the results was recorded.

Hip Circumference (HC)

The HC (cm) was also measured with a measuring tape. It was measured at the largest circumference around the hip. Measurements were taken while standing tall and relaxed with the feet together (or as close together as possible). The measuring tape was kept horizontally all the way around the hip and buttock. Multiple measurements were taken until they were within ¼ inch of each other. An average of the results was recorded.

Waist Hip Ratio (WHR)

The WHR was calculated by dividing the subject's WC by the HC.

Skinfold Thickness (ST) Measurement

ST measurements were taken on the right side of the body with a calibrated Lange skinfold caliper to the nearest 1.0 mm. The same instrument was used throughout the study. The measurement was taken on the following sites of the body; chest, abdomen and thigh.

Body density (BD) values were calculated using the skinfold equation of

Jackson and Pollock for men (Jackson and Pollock, 1978). Percent body fat was calculated from BD using the formula of Siri, with respect to the age of each individual.

Body Density = 1.1093800 – (0.0008267 x sum of skinfolds) + 0.0000016 x (sum of skinfolds) 2 - 0.0002574 x age.

% Body Fat= [(4.95/BD) – 4.5] 100.

Statistical Analysis

Results were presented as means ± S.E.M. Microcal origin 8.0 was used to analyze collected data. Pearsons' correlation coefficients (*r*) were calculated to assess the link and the degree of relation between percentage body fat and all the body fat measurements were. *P* values less than 0.05 were considered statistically significant.

RESULTS

The relationship between waist circumference (WC) and Hip Circumference (HC) and percentage body fat (%BF) showed a positive correlation, stronger than that observed in BMI and %BF. A weak correlation was observed between waist-hip ratio (WHR) and percentage body fat (%BF). Strong positive correlations were observed between skinfold thickness (abdomen, Chest and Thigh) and percentage body fat (%BF). With the Abdomen and Thigh strongly more correlated to %BF than that of the Chest (figure 1).

A negative correlation was observed between height and percentage body fat (%BF). Thus, height may not a reliable method in estimating body fat composition. In this study we also observed a positive correlation between weight and percentage body fat (%BF). A weak positive correlation was observed between estimated lean body mass and percentage body fat (%BF), (figure 2).

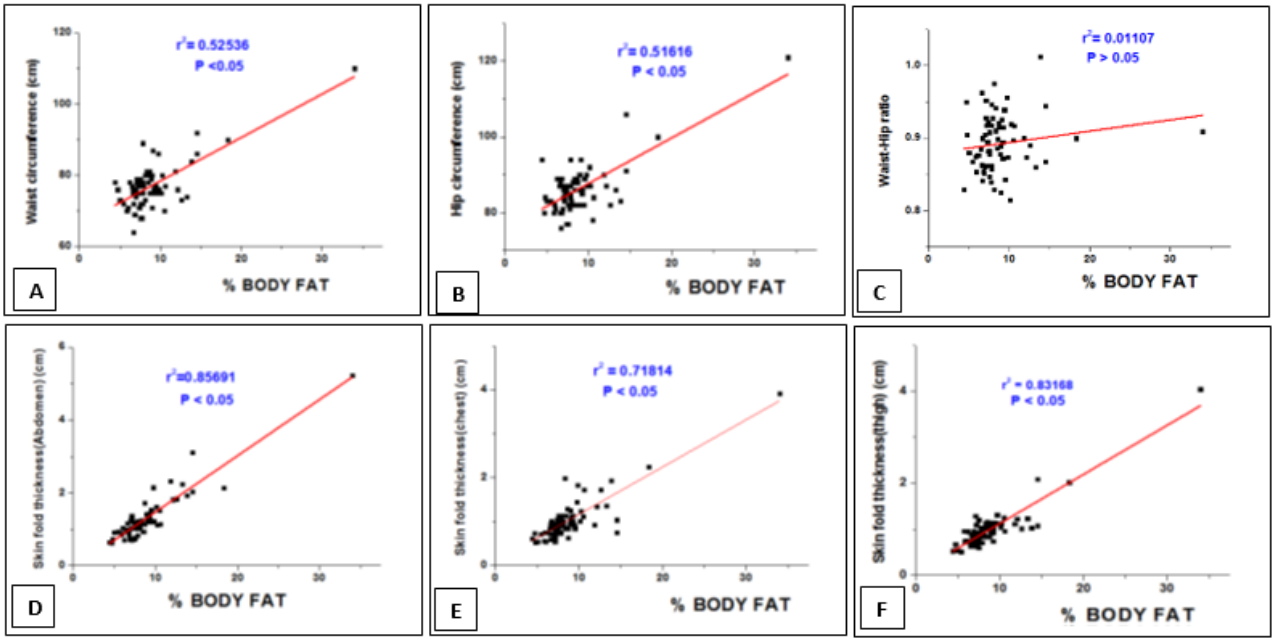

Figure 1. Relationship between percentage body fat and (A) Waist Circumference, (B) Hip Circumference, (C) Waist-Hip Ratio, (D) Abdominal Skin fold thickness, (E) Chest Skin fold thickness and (F) Thigh Skinfold thickness.

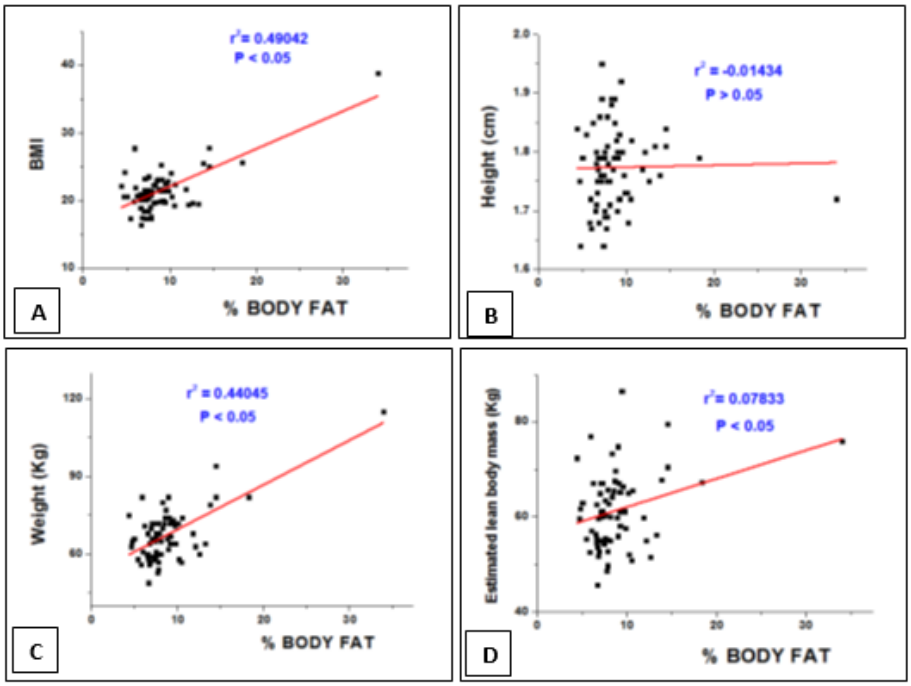

Figure 2. Relationship between percentage body fat and (A) Body Mass Index, (B) Height, (C) Weight and, (D) Estimated lean body mass.

DISCUSSION

Many clinical and epidemiological studies have confirmed the existence of a close relationship between the distribution of body fat, metabolic disorders and increased risk of morbidity and mortality. Thus, the main prognostic problem in obesity is to estimate accurately the quantity and distribution of fat in the body. There however is the problem of most of the gold standard methods for assessing body fat being expensive or even unavailable in this part of the world.

From our study, Body Mass Index (BMI) was positively correlated with percentage body fat (%BF). Ranasinghe *et al*. (2013) reported a strongly positive correlation between BMI and % BF estimated using bioelectric impedance. Meeuwsen (2010) however, documented a not so good relationship between BMI and %BF on a study performed on male UK adults particularly when the BMI is less than 25 kg/m^2. BMI values of most of our participants were between less than 25kg/m^2 this could explain why the correlation observed was not as strong as that observed by Ranasinghe *et al*. (2013). Discrepancies observed in these studies, could be as a result of physiological differences in the characteristics of the study populations and different body composition methodology employed as well.

Our work was in accordance with the work of Giugliano and Melo, (2004) and Freitas *et al*. (2009) who documented significant positive correlations observed between %BF and BMI, WC, HC, skinfold thickness (abdomen), skinfold thickness (thigh), skinfold thickness (chest), weight and estimated lean body mass. WHR and height demonstrated a weak and non-significant correlation with %BF in accordance with WHO, (1995).

Overweight and obesity increase the risk of high blood pressure, reproductive disorders, coronary heart disease, ischemic heart disease, ischemic stroke, type 11 diabetes mellitus and certain cancer Tesfaye *et al*., (2007) hence these cheaper, accurate and available methods of assessing body composition are necessary for screening, diagnosis and research purposes.

In this work, we observed that BMI, WC, HC, skinfold thickness (abdomen), skinfold thickness (thigh), skinfold thickness (chest), weight and estimated lean body mass were positively correlated with %BF in our study population while WHR and height were weakly and negatively correlated with %BF respectively, Our findings support using these alternative means of assessing body fat to predict obesity when more sophisticated methods are unavailable.

REFERENCES

Arterburn, D.E., Crane, P.K, and Sullivan, S.D. (2004). The coming epidemic of obesity in elderly Americans. *J. Am. Geriatr. Soc.* 52:1907-1912.

Chahar, P.S. (2014). Assessment of Body Fat Percentage by Different Methods: A Comparative *European Journal of Sports and Exercise Science* 3 (3):1-6.

de Freitas, S. N., Caiaffa, W. T., César, C. C., Cândido, A. P. C., Faria, V. A., do Nascimento Neto, R. M., and Machado-Coelho, G. L. L. (2007). A comparative study of methods for diagnosis of obesity in an urban mixed-race population in Minas Gerais, Brazil. *Public health nutrition* 10(09):883-890.

Giugliano, R, and Melo, A.L.P. (2004). Diagnosis of overweight and obesity in school children: utilization of the body mass index international standard. *J Pediatr.* 80: 129-134.

Guo, S. S., Roche, A. F., Chumlea, W. C., Gardner, J. D., and Siervogel, R. M. (1994). The predictive value of childhood body mass index values for overweight at age 35y. *The American journal of clinical nutrition*, *59* (4) 810-819.

Horie, L. M., Barbosa-Silva, M. C. G., Torrinhas, R. S., de Mello, M. T., Cecconello, I., and Waitzberg, D. L. (2008). New body fat prediction equations for severely obese patients. *Clinical Nutrition 27*(3):350-356.

Huxley, R., Mendis, S., Zheleznyakov, E., Reddy, S., and Chan, J. (2010). Body mass index, waist circumference and waist hip ratio as predictors of cardiovascular risk – a review of the literature. *Eur. J. Clin. Nutr.* 64: 16-22.

Jackson, A.S, and Pollock, M.L. (1985). Practical assessment of body composition. *Phys. Sport. Med.* 13:76-90.

Meeuwsen, S., Horgan, G. W, and Elia, M. (2010). The relationship between BMI and percent body fat, measured by bioelectrical impedance, in a large adult sample is curvilinear and influenced by age and sex. *Clinical nutrition*, *29*(5):560-566.

Popkin, B.M, and Doak, C.M. (1988). The obesity epidemic is a worldwide phenomenon. *Nutr. Rev.*56:106-114.

Ranasinghe, C., Gamage, P., Katulanda, P., Andraweera, N., Thilakarathne, S, and Tharanga, P. (2013). Relationship between Body mass index (BMI) and body fat percentage, estimated by bioelectrical impedance, in a group of Sri Lankan adults: a cross sectional study *BMC Public Health* **13**:797

Rezende, F., Rosado, L., Franceschinni, S., Rosado, G., Ribeiro, R., *et al*. (2007) Critical revision of the available methods for evaluate the body composition in population-based and clinical studies. *Arch. Latinoam. Nutr*. 57: 327-334.

Seim, H.C. and Holtmeier, K.B. (1993). Treatment of obesity in the elderly. *Am. Fam. Physician*. 47:1183-1189.

Tesfaye, F., Nawi, N. G., Van Minh, H., Byass, P., Berhane, Y., Bonita, R., and Wall, S. (2007). Association between body mass index and blood pressure across three populations in Africa and Asia. *Journal of human hypertension 21*(1):28-37.

World Health Organization (1995). Physical status: the use and interpretation of Anthropometry. *World Health Organ Tech Rep Ser*. 854: 1-452.