Al Ameen J Med Sci 2014; 7(4):307-311 ● US National Library of Medicine enlisted journal ● ISSN 0974-1143

SHORT COMMUNICATION CODEN: AAJMBG

Study of association between body composition and anthropometric dimensions in a population of Indian Army

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Abstract: *Objectives:* To investigate the association of various anthropometric measures with body composition parameters such as percentage of body fat (PBF), fat mass (FM) and fat free mass (FFM). *Material and method:* This study was carried out on randomly selected 373 Gorkha soldiers (age range was 20-48 years) of Indian army. All anthropometric parameters were measured using calibrated anthropometer, sliding caliper, skin fold calipers and inelastic steel measuring tape. Body composition variables were recorded using BIA model TANITA, TBF-310. *Result:* Result indicate that waist circumference (WC) showed the strongest correlations (p=0.000) with FM (r=0.802) and PBF(r=0.758). The highest amount of variation of PBF (57.4%) and FM (64.3%) was explained by WC while hip circumference (HC) explained 37.6% and 52.6% variation of PBF and FM respectively and HC also explained 52.6% variation of FFM. Conicity index (CI) explained low variation of PBF and FM compared to WC and WHR. *Conclusion:* Present study showed that WC has a better association with body fat than rest anthropometric parameters including WHR and CI. Hence the use of WC instead of WHR and CI could be advantageous in study of central adiposity with PBF and FM.
Keywords: Waist circumference, Percentage of body fat, Fat-free mass, skin fold.

Introduction

Anthropometry is a science that measures the body and determines the size, form, symmetry, composition, maturity and performance of man [1]. Although there are several methods to estimate percentage body fat (PBF), there is no 'gold standard' for both epidemiological studies and personal use. However, some scientific societies such as the Spanish Society for Obesity Research recommend the Siri equation, based on anthropometric measures, to determine PBF [2].

But in the present study, PBF, fat mass (FM) and fat free mass (FFM) were measured on the basis of bioelectric impedance method using TANITA body composition analyzer model TBF-310, which is based on two compartment model. The researchers also have agreed on a two-part model of body composition divides the body into a fat component (fat mass) and fat free component (fat free mass) [3]. As for body composition evaluation, FM includes all fat tissue components and FFM describes all the tissues that are not part of FM. The composition of human body is assessed to determine PBF, FM and FFM. However, it is now clear that in addition to the amount of fat in the body, abdominal fat deposition is considered to be the most atherogenic, diabetogenic and hypertensiogenic fat deposition of the human body [4].

The most commonly used measures of adiposity are body mass index (BMI), waist-circumference (WC), waist-hip ratio (WHR) and Conicity index (CI). BMI is a measure of overall adiposity; whereas WC, CI and WHR are the measure of abdominal or central obesity. BMI is also the most commonly used measure of nutritional status and plays an important role specially for female, because the BMI status has an important relationship with birth weight of infants, lactation and infertility [5]. However, a number of studies have shown that it is not appropriate to use a single BMI cut-off point to detect obesity as different BMI-%BF relationships have been observed in different ethnic groups [6-7].

The accumulation of body fat is usually located in the area of the trunk and visceral sites. It is well known that being overweight and obese is closely linked to an increased

risk of cardiovascular disease, as well as with chronic disorders and disabilities [8]. It was found that males who have a WC over 94 cm are at increased risk, and over 102 cm at very high risk for the development of comorbidity, especially of the cardiovascular system. An increased risk of developing these complications was determined in the case of females with a waist size over 80 cm, and a strongly increased risk in the case of females with a waist size of over 88 cm [9].

The present study was done keeping in mind the following aim and objective:-

- To investigate the association of various anthropometric measures with three body composition parameters such as PBF, FM and FFM among Gorkha soldiers of Indian army.
- This type of study on Gorkhas of Indian army is very rare to the best of our knowledge.

Material and Methods

Study sample: This study was performed on 373 Gorkha personnel of Indian Army. These population groups originally belong to Nepal such as Sino tibetian, Kaski and Kathmandu etc. Some of these are also found in India such as Darjeling, Dharmshala and Dehradun. The studied soldiers age range was 20-48 years.

Anthropometric measurement: All anthropometric measurements were made on 373 Gorkha soldiers by trained personnel following standard techniques recommended by Lohman [10]. Height was measured to the nearest 0.1 cm using GPM anthropometers. Circumferences such as mid upper arm circumference (MUAC), HC and WC were measured using an inelastic measuring tape to the nearest 0.1cm. For measurement of the hip circumference, the measurer squatted beside the subject to judge the level of maximum extension of the buttocks.

The left MUAC was measured at the midpoint of the upper arm with the subject's arm relaxed. Waist circumference was measured on a horizontal plane at the narrowest part of the torso (i.e. the smallest horizontal circumference in the area between the ribs and iliac crest). Skinfold thickness on four sites such as biceps (BSF), triceps (TSF), subscapular (SSF) and suprailiac (SISF) of each soldier were measured to the nearest 0.5mm by Eyieken type skinfold caliper.

Conicity index (C I) was calculated from weight, height and waist circumference, using the following equation [11]

C I=Waist Circumference (m)/[0.109*√{Body Weight (kg)/Height (m)}]

Body composition parameters like weight (to the nearest 0.2kg), percentage body fat (to the nearest 0.1%), fat mass (FM) and fat free mass (FFM) were recorded using TANITA Bioelectric impedance analyzer, model TBF-310. All statistical analyses such as mean, Standard deviation, correlation and linear regression were carried out using Statistical Package of Social Science (SPSS) version 11.5.

Results

The mean and SD of measured anthropometric and body composition parameters and some adiposity indicator ratios such as BMI, WHR and CI of studied Gorkha soldier working in Indian Army are shown in table-1. All the anthropometric parameters such as WC, HC, MUAC, skinfold thickness, WHR and CI are have significantly positive correlation with body composition parameter as PBF, FM and FFM.

Linear regression analysis was also carried out with each anthropometric parameter separately to interpret the amount of variation (R^2) of PBF, FM and FFM explained by these measures. Result indicates that the highest amount of variation of FM (64.3 %) and PBF (57.4 %) was explained by WC while hip circumference (HC) explained 37.6%, 52.6 % and 52.6% variation of PBF, FM and FFM respectively. HC also explained 52.6 % variation of FFM. WHR explained only 25.2 % and 22.2 % variation of PBF and FM at significance level (p= 0.000).

Table-1: Anthropometric and body composition characteristics of Gorkha soldiers (n=373)		
Variables	**Mean**	**SD**
Age (years)	33.22	5.34
Anthropometric		
Height (cm)	164.20	5.03
Weight (kg)	66.23	7.00
BMI (kg/m^2)	24.56	2.32
Circumferences		
Waist circumference (cm)	80.61	6.32
Hip circumference (cm)	89.89	4.27
MUAC (cm)	27.50	2.80
Skinfolds		
Biceps SF (mm)	5.07	2.11
Triceps SF (mm)	10.83	4.11
Subscapular SF (mm)	16.14	6.70
Supra iliac SF (mm)	12.70	6.30
Fat distribution		
PBF (%)	18.10	4.30
FM (kg)	12.13	3.79
FFM (kg)	54.06	4.22
WHR	0.90	0.05
CI	1.17	0.06

Table-2: Pearson correlation coefficients and coefficient of determination of variables with fat distribution (n=373)									
Variables	**PBF**			**FM**			**FFM**		
	r	**R^2**	**p-value**	**r**	**R^2**	**p-value**	**r**	**R^2**	**p-value**
WC	0.758(**)	0.574	0.000	0.802(**)	0.643	0.000	0.518(**)	0.269	0.000
HC	0.613(**)	0.376	0.000	0.726(**)	0.526	0.000	0.725(**)	0.526	0.000
MUAC	0.558(**)	0.312	0.000	0.605(**)	0.366	0.000	0.438(**)	0.192	0.000
Triceps SF	0.569(**)	0.324	0.000	0.587(**)	0.344	0.000	0.333(**)	0.111	0.000
Biceps SF	0.526(**)	0.277	0.000	0.552(**)	0.305	0.000	0.333(**)	0.111	0.000
Subscapular SF	0.583(**)	0.340	0.000	0.615(**)	0.378	0.000	0.283(**)	0.080	0.000
Supra iliac SF	0.564(**)	0.318	0.000	0.596(**)	0.355	0.000	0.243(**)	0.059	0.000
WHR	0.502(**)	0.252	0.000	0.471(**)	0.222	0.000	0.104(*)	0.011	0.045
CI	0.447(**)	0.200	0.000	0.434(**)	0.188	0.000	0.122(*)	0.015	0.018
** Correlation is significant at the 0.01 level (2-tailed), * Correlation is significant at the 0.05 level (2-tailed)									

Discussion

All anthropometric parameter like WC, HC, MUAC, triceps and biceps, subscapular and suprailiac skinfold thickness were highly correlated with PBF, FM and FFM (p=0.000).The finding of the present study is in line with the observation of Khatoon et al. (2008) [12]. In the comparison of skinfold thicknesses of biceps, triceps and suprailiac, subscapular skinfold thickness explained the highest amount of variation of PBF and FM. WHR and conicity index were also highly correlated with PBF and FM at the significance level p=0.000 while FFM has a weak correlation.

In an earlier study it was found that the correlation of CI with body composition measures was intermediate between those of WC and WHR [13] but in our result the correlation of CI with body composition measures is lesser, those of WC and WHR and CI have also a weak correlation compare to HC. This result revealed that body fat distribution in Indian army personnel belonging to high altitude population group can be easily explained by WC and HC in comparison of WHR and CI.

Thus the relationship of WC with both (PBF and FM) is much stronger than other anthropometric parameter such as WHR, CI, MUAC and skinfold thickness. The majority of current studies agree that waist circumference (WC) is probably a better indicator of abdominal fatness and cardiovascular disease than either body mass index (BMI) or waist-to-hip ratio (WHR) [14-18]. Another recent study [19] among adult females in the Bengalee population found that WC had the highest correlation with total body fat and explained the largest amount of variation in the same measure. According to the World Health Organization standards for BMI [20], it was found that the BMI of Gorkha soldier working for Indian Army was found in normal range in the present study. The value of waist circumference 80.61 cm and WHR 0.90 as shown in table-1 shows that Gorkha soldier below the risk of cardiovascular disease [21-22]. It is clear from table-2 that each anthropometric parameter except WHR has strong relationship with FM compare to PBF.

Conclusion

Anthropometric parameter like waist circumference, hip circumference, mid upper arm circumference, triceps, biceps, subscapular and suprailiac skinfold thickness are significantly correlated with percentage of body fat, fat mass and fat free mass but the relationship of WC with both PBF and FM is much stronger than other anthropometric parameter such as WHR, CI, MUAC and skinfold thickness.

Acknowledgement

I would like to convey my gratitude and special thanks to our Director Dr. Shashi Bala Singh, HOD of Anthropology Group, Dr. Usha Panjwani. We are also thankful to the Gorkha soldiers of Indian Army who gave their precious time for the study and Defence Institute of Physiology and Allied Sciences, DRDO for funding the project.

References

1. Marrie RA, Goldman M. Validity of performance scales for disability assessment in multiple sclerosis. *Mult Scle.* 2007; 13(9):1176-1182.
2. Spanish Society for the Study of Obesity**.** Spanish consensus for the evaluation of obesity and to carry out epidemiologic studies. *Med Clin (Barc).*1995; 107:782-787.
3. Kravitz L, Heyward V. Getting a grip on body composition. *IDEA Today,* 1992; 10(4):34-39.
4. Kopelman PG. Obesity as a medical problem. *Nature.* 2000; 404: 635-643.
5. WHO: Physical Status: The Use and Interpretation of Anthropometry. Report of a Expert Committee. Technical Report Series No. 854. *WHO, Geneva,* 1995.
6. Deurenberg-Yap M, Schmidt G, van Staveren WA, Deurenberg P. The paradox of low body mass index and high body fat percentage among Chinese, Malays and Indians in Singapore. *Int J Obes* 2000; 24: 1011-1017.
7. Deurenberg P, Bhaskaran K, Lian PL. Singaporean Chinese adolescents have more subcutaneous adipose tissue than Dutch Caucasians of the same age and body mass index. *Asia Pacific J Clin nutr* 2003; 12:261-265.
8. Musta A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden with overweight and obesity. *Journal of American Medical Association*. 1999; 282(16):1523-1539.

9. World Health Organization (WHO). Obesity-preventing and managing the global epidemic. Report of WHO consultation on obesity. *Geneve, 7-17. WHO*, 1997.
10. Book*:* Lohman TG, Roche AF, Martorell R. Anthropometric Standardization Reference Manual. *Human Kinetics s, Chicago*.1988**.**
11. Valdez R. A simple model-based index of abdominal adiposity. *J Clin Epidemiol* 1991; 44:955-6.
12. Khatoon Z, Tapadar JR, Chatterjee D, Chanda S, Ghosh JR, Bandyopadhyay AR. Relationship between anthropometric measures and body composition among Muslim females of West Bengal, India. *Anthropol Anz,* 2008; 66(3):349-53.
13. Chatterjee D, Ghosh JR, Sudeshna Chanda, Bandyopadhyay AR. Relationship Between Anthropometric Measurements and Body Composition Among Santal Girls Aged Between 6-18 Years of Galudih, Jharkhand, India. *Anthropologist*. 2006; 8(4): 241-243.
14. Ledoux M, Lambert J, Reeder BA, Despres JP. A comparative analysis of weight to height and waist to hip circumference indices as indicators of the presence of cardiovascular disease risk factors. Canadian Heart Health Surveys Research Group. *Can Med Assoc J*. 1997; 157(Suppl 12): S32-S38.
15. Reeder BA, Senthilselvan A, Despres JP, Angel A, Liu L, Wang H, Rabkin SW. The association of cardiovascular disease risk factors with abdominal obesity in Canada. Canadian Heart Health Surveys Research Group. *Can Med Assoc J*. 1997; 157(Suppl 1): S39-S45.
16. Seidell JC, Cigolini M, Charzewska J, Ellsinger BM, di Biase G. Fat distribution in European women: a comparison of anthropometric measurements in relation to cardiovascular risk factors. *Int J Epidemiol*. 1990; 19:303-308.
17. Seidell JC, Cigolini M, Charzewska J, Ellsinger BM, Deslypere JP, Cruz A. Fat distribution in European men: a comparison of anthropometric measurements in relation to cardiovascular risk factors. *Int J Obes Relat Metab Disord*. 1992; 16:17-22.
18. Ledoux M, Lambert J, Reeder BA, Despres JP. Correlation between cardiovascular disease risk factors and simple anthropometric measures. Canadian Heart Health Surveys Research Group. *Can Med Assoc J*, 1997; 157(1 Suppl):S46-S53.
19. Ghosh JR, Bandypadhyay AR. Waist circumference as measure of total body fat in Asian Indians. *Int J body Comp Res,* 2007; 5(3):89-93.
20. World Health Organization. Obesity: preventing and managing the global epidemic. Report of a WHO consultation on obesity. *WHO: Geneva, 3-5 June* 1997.
21. Lemieux S, Prud'homme D, Bouchard C, Tremblay A, Despres JP. A single threshold value of waist girth identifies normal-weight and overweight subjects with excess visceral adipose tissue. *Am J Clin Nutr*. 1996; 64:685-693.
22. Lean ME, Han TS, Morrison CE. Waist circumference as a measure for indicating need for weight management. *Br Med J*. 1995; 311:158-161.

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