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PREVALENCE OF ABDOMINAL OBESITY AND ITS ASSOCIATION WITH BODY COMPOSITION INDICES IN YOUNG ADULT INDIAN FEMALES

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ABSTRACT

The present research investigation was aimed to have estimates on body composition of centrally obese young adults in the age group of 18-28 years old with a sample size of 629. Anthropometric measurements were taken using standard procedures. Mean values for Body Mass Index (BMI) were shown as19.0±2.8 and 23.4±2.9 kg/m^2 at waist circumference cut off points viz., <80 cm. and ≥80 cm respectively which were significantly different (<0.01) at 1 per cent level. Higher mean values of anthropometric characteristics were observed at ≥80 cm. thresholds. Body composition using bioelectrical impedance analysis (BIA) showed that lower means for Fat Free Mass (%) (FFM) and Total Body Water (%) (TBW) were exhibited at ≥80 cm. Fat (%) and fat (kg) had higher mean values at ≥80 cm. Prevalence of abdominal obesity was observed as 29.41 per cent. A high prevalence of abdominal adiposity was observed in 23-28 years age groups than that of 18-23 years group indicating likelihood of development of chronic disease later in life. Mean value for fat (%) was exhibited as 19.0±4.4 and 29.2±5.6 at waist circumference cut off points viz., <80 cm. and ≥80 cm respectively which were significantly different (<0.05) at 5 per cent level.

Key words: Body composition, bioelectrical impedance analysis, waist circumference, abdominal obesity, fat mass.

INTRODUCTION

Body could be conceived as groups of constituents *i.e.* sum of atoms, molecules, cells, tissues, organs and sum of all systems (Wang et al 1992). Chemical compositions of more than 100,000 substances ranging from simple to complex are identified in human body. Among these, water, lipids, proteins, carbohydrates and minerals are major molecules. Water makes 50 per cent and 60 per cent of body composition in women and in men respectively of which 26 per cent of this is extracellular and 34 per cent is intracellular (Mattsson and Thomas 2006). For athletes, body fat percent can be below 10 per cent, it may be more than 50 per cent for obese individuals. Proteins make 15 per cent of the body composition and minerals make 5 per cent (Wang et al 2005).Two compartment model consists of fat mass and fat-free mass is widely used. FFM can be divided into water, protein and mineral (Wang et al 1992).

Body fat distribution as a risk factor plays a very important role for development of obesity-related diseases. Excess abdominal fat is known to be associated with an increased risk of cardio-metabolic disease. However, precise measurement of abdominal fat content is expensive; it requires the use of radiological imaging techniques. Therefore, waist circumference (WC) is often used as a surrogate marker of abdominal fat mass, because waist circumference is correlated with abdominal fat mass (subcutaneous and intra-abdominal) (Pouliot et al 1994) and is associated with cardio-metabolic disease risk (Kissebah et al 1982).

Abdominal obesity is subjected to the presence of visceral adipose tissue (VAT) which promotes insulin resistance, dyslipidaemia, and hypertension (Tchernof et al 1996; Pouliot et al 1992; Despres et al 1990). Waist circumference and WHR are measures of VAT. Both measures are correlated with VAT however, waist circumference is more strongly associated with VAT (Kamel et al 1999; Onat et al 2004; Pouliot et al 1994). Prospective and cross-sectional studies revealed that visceral obesity is closely related to impaired glucose tolerance (Hayashi et al 2003), dyslipidemia (Pascot *et. al* 1999) hypertension (Sironi *et.al* 2004), insulin resistance (Wagenknecht et.al 2003; Goodpaster *et al* 2003) and metabolic syndrome (Carr *et al* 2004). In the evaluation of malnourished and thin people, body composition analysis can be employed. Body composition measurements may be useful for identifying patients who do not have an increase in overall body fat, but who have an increase in visceral fat (Baumgartner, 2000). Waist circumference measurement has been recommended by the United States National Cholesterol Education Program for assessment of abdominal obesity, whereas World Health Organization suggests WHR for measurement of central obesity (WHO, 1997). In an urban slum of Chennai, central obesity was observed to be higher with advancing age among slum women aged 20 years and above

belonging to high socio-economic status (Anuradha *et al* 2012). Among postmenopausal women in Zaria, higher BMI and waist circumference have been exhibited than that of premenopausal women indicating likelihood of developing future metabolic aberrations. (Achie *et al* 2012). Therefore, the present research investigation was confined with the objectives to determine prevalence of abdominal obesity young adult females and to study their body composition and nutritional status.

MATERIALS AND METHODS

SAMPLE SELECTION

In the present investigation, University girl students of Pantnagar (Uttarakhand) were selected in the age range of 18-28 years.

SAMPLING DESIGN

Study subjects were selected using simple random sampling without replacement technique.

INFORMED CONSENT

Purpose of the study was clearly explained to study subjects. Written informed consent was obtained from respondents prior to inclusion in the study.

SAMPLE SIZE

According to NFHS 3 (2005-06) survey, prevalence of over nutrition is 16 per cent (NFHS-2005-06). This fact was taken into consideration for determination of sample size. It was assumed that at 99 per cent confidence interval with 5 per cent of precision level having expected prevalence of 16 per cent for overweight or obesity. To achieve target of 16 percent prevalence of overweight and obesity, the desired sample size should have been 425. There are approximately 2000 girl students in University. In the present study, 629 young adult volunteered to participate.

NUTRITIONAL ANTHROPOMETRY

Anthropometric variables such as height, weight, MUAC, waist circumference, hip circumference, skin folds were recorded as per standard methods (Gibson 1990).

NUTRITIONAL STATUS

Nutritional status was assessed using International Obesity Task Force (IOTF) proposed BMI cut off points. A BMI cut off point of ≥23 kg/m^2 denotes overweight and obesity suggested for Asian Indians considering that Asians have higher body fat percentage than that of Caucasian population of same age sex and BMI (Weisell 2002).

BODY COMPOSITION ASSESSMENT

Information on body composition parameters was obtained using Bioelectrical Impedance Analysis (Maltron Bioscan Analyser, 916). For body composition assessment, study subjects were asked to lay down in a supine position. Electrodes were placed on a hand and foot and consequently, a small alternating electrical current is passed through these electrodes. The impedance to the current flow is measured. The electrical impedance of body tissues is measured by BIA and used to have estimates on fluid volumes, TBW, Body Cell Mass, (BCM) and FFM.

ABDOMINAL OBESITY CUT OFF POINTS

Abdominal obesity among young adult females was assessed using waist circumference cut off point i.e. ≥80 cm. (Satyanarayan and Subbalakshmi 2012; Misra *et al* 2006).

STATISTICAL ANALYSIS

Statistical analysis was done using SPSS programme for anthropometric and body composition indices using percentage, mean, standard deviation z test, correlation coefficient and simple regression analysis.

RESULTS

The population characteristics involves average height, weight and BMI was seen as 156.6±5.8 cm., 49.9±8.9 kg. and 20.3±3.4 kg/m^2 respectively for total study samples. Mean value for MUAC was found to be 25.6±10.4 cm. Variables such as waist circumference and hip circumference had mean values viz. 75.9±8.3 cm. and 91.3±6.0 cm. respectively. Waist: Hip Ratio (W:HR) was found to have mean value of 0.83±0.05. Mean values were obtained viz. 20.5±4.2 mm, 8.1±3.2 mm, 13.9±3.9 mm, 17.4±5.5 mm. and 60.1±13.9 mm for triceps, biceps, sub-scapular, suprailiac and sum of SFT respectively.

PREVALENCE OF OVER-NUTRITION

Prevalence rate of over nutrition comprising 16.06 per cent and normal 54.21 per cent has been found to be for total study samples i.e. 629.

Table-1 Percent wise categorization of study participants as per BMI (IOTF proposed)

BMI(IOTF proposed)	18-28 years N=629	
	n	(%)
<18.5 (Undernourished)	187	29.73
18.5-23 (Normal)	341	54.21
23-25 (At risk of obesity)	55	8.74
25-30 (Overweight)	42	6.68
30-35 (Obesity)	4	0.64

NUTRITIONAL ANTHROPOMETRY AS PER WAIST CIRCUMFERENCE CUT OFFS

In the present investigation, young adult female population has been distributed as per waist circumference cut off points viz. <80 cm and ≥80 cm. More than equal to 80 cm. depicts increased risk of metabolic complication (Satyanarayan and Subbalakshmi 2012; Misra et al 2006). It was observed that lower means were seen for all anthropometric indices at cut off point of <80 while at cut-off point of ≥80, results showed relatively higher mean observations for the same. Respondents with waist

circumference of ≥80 cm were having generalized obesity as evident from mean value of BMI i.e. 23.4±2.9. Statistically significant difference at 5 per cent level ($p<0.05$) was present for mean values of all anthropometric variables between waist circumference cut offs viz. <80 cm. and ≥80 cm. (Table-1).

Table-2 Anthropometric characteristics of abdominally obese and non-abdominally obese study participants with respect to waist circumference

S. No.	Anthropometric characteristics	Mean±SD		N= 629
		Waist circumference (cm.)		
		n (%) 444 (70.5)	n (%) 185 (29.4)	Z value
		<80	≥80	
1	Age	21.6±2.8	22.7±2.8	4.51**
2	Height (cm.)	156.5±5.5	157±6.5	0.81^{NS}
3	Weight (kg.)	46.6±7.4	57.8±7.1	17.63**
4	BMI (kg/m^2)	19.0±2.8	23.4±2.9	17.63**
5	Mid upper arm circumference (cm)	24.7±11.3	27.9±7.5	4.05**
6	Waist circumference (cm.)	71.7±4.9	86.1±5.8	29.69**
7	Hip circumference (cm.)	88.8±4.3	97.1±5.6	17.80**
8	W:Hip Ratio	0.81±0.04	0.89±0.04	20.31**
9	Triceps (mm.)	19.5±4.1	23.1±3.2	11.70**
10	Biceps(mm.)	7.1±2.6	10.6±3.0	14.00**
11	Subscapular (mm.)	12.5±3.2	17.1±3.7	14.62**
12	Surailiac (mm.)	16.2±5.1	20.3±5.4	8.61**
13	Sum of SFT (mm.)	55.4±12.1	71.3±11.6	15.36**

**Significant at 1 % level NS = Non-significant

PREVALENCE OF ABDOMINAL OBESITY

In the present research, waist circumference cut off point i.e. ≥80 cm. has been used for determining prevalence of abdominal obesity. Out of total subjects studied, prevalence of abdominal obesity has been recorded as 29.41 per cent subjects who are at risk of developing future metabolic aberrations. Prevalence of abdominal obesity has been observed as 9.38 per cent subjects using ≥88cm waist circumference cut off points. Majority of study subjects i.e. 93.62 per cent were not having abdominal obesity whereas merely 6.38 per cent subjects were found at risk of future metabolic complications for 18-23 years age group. Pertaining to 23-28 years age group around 87.33 per cent of study subjects had no abdominal obesity while about 12.67 per cent subjects were observed to have abdominal obesity.

In 18-23 years age group, majority of subjects i.e. around 77.51 per cent were having no central obesity whereas about 22.49 per cent subjects were found to have abdominal obesity while in age group of 23-28 years about 63.00 per cent subjects were recorded to have no abdominal obesity and approximately 37.00 per cent participants had abdominal obesity. A higher prevalence of central obesity was represented in 23-28 years are group when compared to 18-23 years age group addressing an influence of age on development of abdominal obesity as shown in Figure-1.

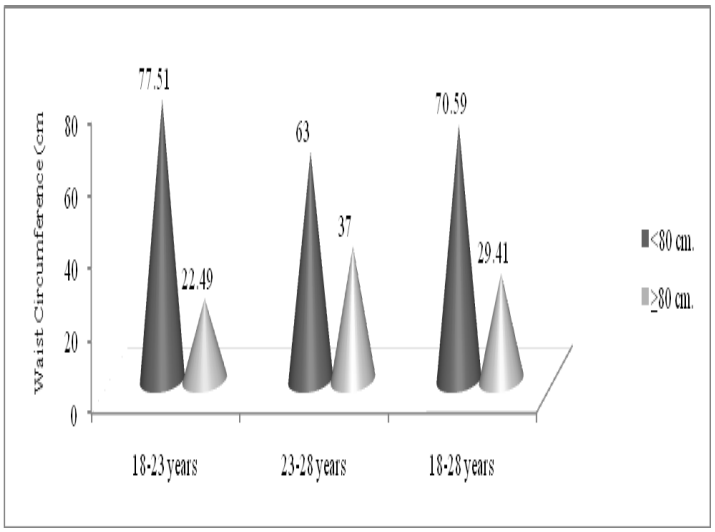

Fig. 1 Categorization of study participants as per waist circumference thresholds

BODY COMPOSITION

Higher mean values were shown for FFM (%), TBW (%), Extra Cellular Water (ECW) (%) and ECW: ICW respectively for the subjects at risk of metabolic complications at cut off point of <80 than that of cut off point of ≥80. For parameters such as FFM (kg), fat (kg), fat (%), TBW (lt), intracellular water (ICW) (lt), ICW (%), Body Cell Mass (BCM) (kg), Extra Cellular mass (ECM) (kg), body protein (kg), body mineral (kg), muscle (kg), body potassium (g) and body calcium (g) lower means have been recorded for cut-off point of ≥80 cm than that of <80 cm for the same. Study participants with waist circumference of ≥80 had abnormal body fat per cent as indicated by mean value of body fat i.e. 29.2±5.6 (%). At normal BMI, healthy body fat per cent is reported to be 21 per cent (Gallagher et al 2000). Hence, waist circumference can be used as a risk assessment tool. All body composition parameters were significantly different at 5 per cent level ($p<0.05$) at two waist circumference cut off points viz. <80 cm. and ≥80 cm. indicating subjects are at risk of metabolic disturbances (Table-3).

The Body mass index (BMI) serve as an indicator of overall adiposity and recognized as an indicator for assessment of adult nutritional status (Lee and Nieman 2003). Approximately 63.8 per cent women belonged to the category of normal, 18.9 per cent were low weight normal, 8.8 per cent were chronic energy deficient and 8.3 per cent women were obese (Grade I) in Uttarakhand (Dobhal and Raghuvanshi 2008).

Table-3 Body composition characteristics with respect to waist circumference cut offs

S. No.	Variables	Mean±SD N= 629		
		Waist circumference (cm.)		
		<80	≥80	Z value
1	Fat free mass (kg)	37.3±2.9	40.5±3.2	11.57*
2	Fat free mass (%)	80.9±4.4	70.7±5.6	21.86*
3	Fat (kg)	9.0±3.0	17.2±5.3	19.43*
4	Fat (%)	19.0±4.4	29.2±5.6	21.86*
5	Total body water (lt)	25.7±1.8	28.5±2.4	13.68*
6	Total body water (%)	55.9±3.6	49.6±3.1	21.76*
7	Extracellular water (lt)	11.0±0.9	11.6±1.0	6.58*
8	Extracellular water (%)	42.8±2.0	40.8±2.0	11.36*
9	Intracellular water (lt)	14.7±1.1	16.8±1.6	15.84*
10	Intracellular water (%)	57.1±2.0	59.1±2.0	11.36*
11	Extracellular water: Intracellular water ratio	0.7±0.06	0.69±0.05	11.71*
12.	Body cell mass (kg)	20.0±1.5	22.4±1.8	15.36*
13	Extracellular mass (kg)	17.2±1.5	18.0±1.6	5.82*
14	Body Protein (kg)	8.2±1.0	8.5±1.0	3.71*
15	Body Mineral (kg)	3.3±0.4	3.4±0.4	3.85*
16	Muscle (kg)	16.9±1.4	18.6±1.4	13.53*
17	Body potassium (g)	88.6±6.6	99.0±8.1	15.25*
18	Body calcium (g)	759.3±52.3	837.6±59.3	15.59*

*Significant at 5% level (p<0.0)

36 percent of women and 34 per cent of men are observed to be undernourished with a BMI less than 18.5 denoting a high prevalence of nutritional deficiency. Overweight and obesity are emerging problems in India. 13 percent of women and 9 percent of men have been reported as overweight or obese. Occurrence of over nutrition and under nutrition signifies that adults in India are suffering from dual burden of malnutrition (NFHS-2005-06). All these results support the findings of present study where prevalence of over-nutrition and under-nutrition is 16.06 per cent and 29.73 per cent addressing double burden of malnutrition in study subjects.

Waist circumference and waist: hip ratio serve as measures of central obesity and body mass index (kg/m2) is used as a measure of generalized obesity. Study results are corroborative with the study done by Weisell (2002) found that about 62 per cent subjects were exhibited to have normal waist circumference with mean 71.95±4.83 cm. Remaining 38 per cent were prone to develop abdominal obesity. Out of these 38 per cent, 29.33 per cent were at risk for metabolic aberrations with mean waist circumference 95.16±8.06 cm.

In the age range of 18-21 years, around 62 per cent of subjects had normal WC (<80 cm) with mean per cent body fat 30.79±2.28. Approximately 29.33 per cent of subjects with risk of metabolic syndrome had waist circumference between 80 and 88 cm. Their mean per cent body fat was 33.55±1.55 and only 8.66 per cent had increased susceptibility for metabolic syndrome with their mean per cent body fat 36.37±2.55 (WC>80cm) (Bisla and Bansal 2009). These findings are corroborative with results of the present study where 29.41 per cent study participants are at risk of developing metabolic disturbances later in life. Results of the present study reveal that respondents who were having abdominal obesity had generalized obesity.

Study findings are consistent with the study done by Flegal *et al* (2009), where they observed that men and women in the age group of 20 to 80 years had percentage body fat 28.1±0.10 and 39.9±0.16 respectively. For men, per cent fat was revealed to be significantly highly correlated with waist circumference or with waist to stature ratio than with BMI except in oldest age group in which the differences were not statistically significant. For women, per cent body fat was found to be significantly highly correlates with BMI than with waist circumference (WC), except in the oldest age group in which the difference was not statistically significant.

CORRELATION COEFFICIENTS

Waist circumference was found to be negatively correlated at 1 per cent level of significance (p<0.01) with FFM (%), TBW (%), ECW (%) and ECW/ICW whereas positive association at 1 per cent level of significance (p<0.01) was observed with rest of the body composition parameters. It may be because fat mass has got less percentage of water in comparison to FFM. (Table-4)**.**

SIMPLE REGRESSION ANALYSIS

Simple regression analysis was performed for the indices waist circumference, fat mass (%) and fat free mass (%). Two simple regression equations were formed in which waist circumference was considered as independent variable; fat mass (%) and fat free mass (%) as dependent variables. These equations will help in assessing fat mass (%) and FFM (%) using simple measurement of waist circumference. A R^2 value of 0.684 has been reported for both equations. Relationship between waist circumference and FFM; waist circumference and fat mass was observed to be significant (p<0.01) at 1 per cent level.

Simple regression equations developed were as:

Fat (%) = 0.661x-28.21……Equation I (Fig. 2) where; x = waist circumference; y = Fat (%)

FFM (%) = -0.661x+128.2……..Equation II (Fig. 3) where; x = waist circumference; y = FFM (%)

Table-4 Correlation coefficients between waist circumference and body composition variables

S. No.	Body composition parameters	Correlation coefficients 'r' value
1	Fat free mass (%)	-0.826**
2	Fat (%)	0.827**
3	Total body water (%)	-0.798**
4	Extracellular water (%)	-0.533**
5	Intracellular water (%)	0.533**
6	Extracellular water: Intracellular water ratio	-0.531**
7	Body cell mass (kg)	0.708**
8	Extracellular mass (kg)	0.347**
9	Body Protein (kg)	0.273**
10	Body Mineral (kg)	0.273**
11	Muscle (kg)	0.647**
12	Body potassium (g)	0.704**
13	Body calcium (g)	0.703**

**Significant at 1 % level (p<0.01)

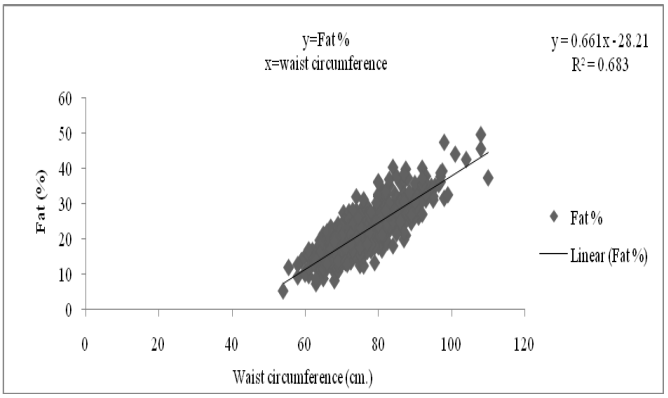

Fig. 2 Association between waist circumference and fat (%)

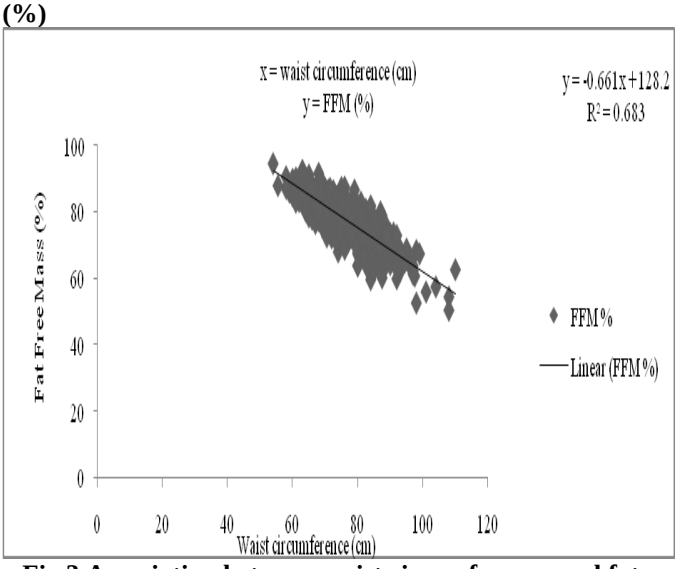

Fig.3 Association between waist circumference and fat free mass (%)

CONCLUSION

Results from the present investigation revealed that an effect of age on anthropometric characteristics as exhibited by a high prevalence of generalized as well as abdominal obesity was observed in 23-28 age group when compared to 18-23 age group. It was observed that subjects with abdominal obesity were recorded to have higher mean values for variables such as BMI, MUAC and W: HR than those of subjects having no abdominal obesity. Likewise, the same phenomenon was noticed for fat (%) indicating that abdominally obese study subjects are more prone to have high body fat, BMI, MUAC and WHR. Hence, waist circumference can be used as a measure of risk assessment tool. Double burden of malnutrition is observed in the present study. BIA is being an expensive technique for measure of body fat. Rather than using BIA, waist circumference can be used as a measure of risk assessment tool for future assessment of chronic diseases which can be incorporated as a health measure tool in national nutrition surveys which in turn assist in policy making. Thus, development of central obesity at young stage may result in an increase in health complications like metabolic syndrome risk later in life. The regression equation using waist circumference may be used as screening tool for assessing metabolic aberrations.

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