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RELATIONSHIP BETWEEN ANTHROPOMETRIC INDICATORS AND PERCENT BODY FAT IN ADULT OVERWEIGHT WOMEN AGED 20-50 YEARS

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ABSTRACT

Adiposity is a predictive factor for many metabolic and non-communicable diseases. Objectives of the study are a) to find out the prevalence rate of obesity among overweight women in rural areas of Nellore town. b) to assess the nutritional status by anthropometry and assessing the body fat by Bioelectrical Impedance Analysis (BIA). c) to study the relationship between body fat & anthropometric measurements. A community based cross sectional study. 100 rural overweight women age (20-50 years) are subjects of this study. Anthropometric measurements were taken using standard procedure-each study subject was subjected to weight, height, waist circumference, hip circumference, waist-to-hip ratio and skin fold thickness. There is statistically significant differences are established for all age groups at 5% level with regard to body fat, waist circumference and BMR values. Body Mass Index(BMI) were shown as 55% under grade-I 25-29.9kg/m2, 37% were under grade II 30-40kg/m2,8% were under not obese <25kg/m2 respectively which were significant at 5% level. Many of body measurements showed significant correlation with body fat. Body fat had a positive and significant relation with Triceps, Biceps, Chest, Suprailiac, Waist circumference, Hip circumference, Mid Upper Arm circumference and BMI, whereas waist-to-hip ratio had shown no significant correlation with body fat and other body measurements.

Key words: Obesity, Body Mass Index, Bio Electrical Impedance, Waist circumference, BMR, Body fat

INTRODUCTION

Obesity develops when energy intake continuously exceeds energy expenditure, causing fundamental chronic energy imbalance. Adiposity is a predictive factor for diabetes (Fagot 2000, Hyponen *et al* 2000) cardiovascular diseases (Singh 1999) and disability in the elderly (Visser *et al* 1998). Prevalence of obesity has increased dramatically over the past 30 years in both developed and developing countries (Gutierrez *et al* 2000, Olds 2001, Caballero 2001).

Body Mass Index (BMI) is a measure of overall adiposity, whereas, waist circumference (WC), waist-hip-ratio (WHR) are reliable proxy measures of abdominal fat (Bose and ascie1998,Kopelman). On the other hand, central adiposity has been linked to increased risk of cardiovascular disease, hypertension and diabetes by many studies (Venkataramana and reddy 2002, Grievink 2004, Wang 2005).There are many studies in Indian population dealing with central adiposity and cardiovascular risk factors (Gupta and Mehrishi1997, Misra *et.al* 2001, Deshmukh *et.al* 2006, Anand *et.al* 2007) and Diabetes (Snehalatha *et al* 2003, Ramachandran *et al* 2004). But little attempts have made (Bose 2006, Ghosh 2007, Dasgupta and Hazra 1999, Krupad 2004) to identify the best abdominal measure to predict BMI and PBF.

Foot-to-foot Bio Metrical Impedance Analysis (BIA) provided a convenient method for the measurement of body composition in large populations. According to the National Institutes of health technology assessment conference statement on BIA in body composition measurement (NIHT conference, 1996), BIA is a more accurate than BMI and may be more accurate than skinfolds measurements for the estimation of comparative fat mass. Accuracy of BIA and skinfolds estimation of fat percentage has been validated against reference methods in adults (Eaton et al 1993, Desport *et al* 2000, Swinburn *et al* 1999, Reilly *et al* 1994).

Overweight and obesity has emerged a major disorder associated with many metabolic diseases in both developed and developing countries. Globally it is predicted that by 2020 non-communicable diseases will contribute to 80% of the global burden of disease causing

7 out of 10 deaths in developing countries (Boutayeb and Boutayeb 2013)

With this background this study was completed in the Nellore rural areas of venkatachalem and kanupuru, with the following objectives:

1) To find out the prevalence rate of obesity among overweight women in rural areas of Nellore town
2) To assess the nutritional status by anthropometry and assessing the body fat by Bioelectrical Impedance Analysis(BIA)
3) To study the relationship between body fat & anthropometric measurements.

MATERIALS AND METHODS

SAMPLE SELECTION

In the present investigation, rural overweight women of Nellore were selected in the age range of 20-50 years.

SAMPLE DESIGN

A community based cross sectional design was adopted for this study

SAMPLE SIZE

Women of 20-50 years were considered for this study. Normal weight& low weight women were excluded. Total sample size was 100.

NUTRITIONAL ANTROPOMETRY

Nutritional status was assessed using Dietetics, B.Srilakshmi, sixth edition(2011) proposed BMI cut off points. A BMI cut off points of >_25kg/m2 denotes obesity. The relative risks of developing hypertension among compared with the underweight, normal weight and overweight persons. Females with obesity had a risk of hypertension three times that of a normal weight female based on BMI (Rufus et al 2008).

BODY COMPOSITION ASSESSMENT

Information on body composition parameters was obtained using Bioelectrical Impedance Analysis (BIA). For body composition assessment study subjects were asked to hold the BIA machine with their hands in standing position. Electrodes were passed through hand and measured the body fat, BMR and body type. Body fat cut off points were 20-30% Normal, 31-33% borderline and >33% obesity (Srilakshmi, 2011).

ABDOMINAL OBESITY CUT OFF POINTS

Abdominal obesity among adult females was assessed using waist circumference cutoff point i.e. <88cm and >88cm (Srilakshmi, 2011).

STATISTICAL ANALYSIS

Statistical analysis was done chi-square and p-value for BMI, Body fat and Body type and body composition indices using mean, standard deviation, f-value, p-value, correlation coefficient.

DESCRIPTIVE STATISTICS OF VARIOUS CHARACTERISTICS IN RELATION TO OBESITY

Table shows the difference among different Anthropometric measurements, body fat with age.

There is statistically significant differences are established for all age groups at 5% level with regard to body fat, waist circumference and BMR values. No significant impact of age on weight, Height, BMI, Triceps, biceps, chest, suprailiac, hip circumference, w/H ratio, MAUC. It shows that which subjects contains high body fat, waist circumference and they were at risk for getting so many metabolic disorders. Therefore, the objective of the present study was to find out the most effective and simple anthropometric measure of abdominal adiposity to predict BMI as well as PBF.

Kurpad (2003) showed that waist circumference correlated better with BMI than WHR. Ghosh (2007) showed that females in the Bengalee population found that waist circumference had the highest correlation with total body fat and explained the largest amount of variation in the same measure.

Katherine *et.al* (2008) showed that waist circumference, WSR, and BMI were significantly more correlated with each other than with percentage body fat. Percent body fat tended to be significantly more correlated with waist circumference than with BMI in men but significantly more correlated with BMI than with waist circumference in women.

Soha *et al* (2012) showed that total abdominal and subcutaneous fat areas had a significant positive correlation with body weight, BMI, waist, hip measurements and FM. Total abdominal fat had a significant positive correlation with total abdominal fat and waist in obese group.

Keiko (1998 – 1994) showed that there were significant interaction between sex and anthropometric measurements in predicting percent body fat, women, percent body fat was significantly higher in those with shorter height, shorter leg length and lower leg length – to – height ratio, even after adjustment for potential cum founders.

The subjects were distributed according to their BMI basing on their age. Majority (54.3%) were in the age group of 41 – 50 years. Who are classified as Grade II obese. Whereas 26.3% to 29.6% were in the age group of 31 – 40 years and 20 – 30 years and are classified as grade II obese. Very limited percentages 11.1% in the age group of 20 – 30 years and 11.4% in the age group of 41 – 50 years, and only 2.6% are in the age group of 31 – 40 years are normal.

RESULTS

Table 1- Descriptive Statistics of various characteristics in relation to obesity

	Age	N	Mean	Std. Deviation	F-value	p-value
Weight	20 - 30	27	66.70	7.4	2.488	0.088
	31 - 40	38	63.68	5.4		
	41 - 50	35	67.46	9.6		
	Total	100	65.82	7.7		
Height	20 - 30	27	151.89	5.8	2.881	0.061
	31 - 40	38	148.53	6.1		
	41 - 50	35	148.66	6.3		
	Total	100	149.48	6.2		
BMI	20 - 30	27	28.94	4.2	1.946	0.148
	31 - 40	38	28.86	2.4		
	41 - 50	35	30.40	4.3		
	Total	100	29.42	3.7		
Body Fat	20 - 30	27	37.78	4.4	3.001*	0.044
	31 - 40	38	38.47	3.3		
	41 - 50	35	40.08	4.0		
	Total	100	38.85	3.9		
Triceps	20 - 30	27	1.35	0.2	0.344	0.710
	31 - 40	38	1.34	0.1		
	41 - 50	35	1.37	0.2		
	Total	100	1.35	0.2		
Biceps	20 - 30	27	1.13	0.1	0.930	0.398
	31 - 40	38	1.16	0.1		
	41 - 50	35	1.18	0.1		
	Total	100	1.16	0.1		
Chest	20 - 30	27	1.05	0.1	1.576	0.212
	31 - 40	38	1.06	0.1		
	41 - 50	35	1.09	0.1		
	Total	100	1.07	0.1		
Suprailiac	20 - 30	27	1.33	0.2	1.055	0.352
	31 - 40	38	1.34	0.1		
	41 - 50	35	1.38	0.2		
	Total	100	1.35	0.2		
Waist Circumference	20 - 30	27	92.01	9.5	2.392*	0.047
	31 - 40	38	91.14	6.0		
	41 - 50	35	95.52	10.8		
	Total	100	92.91	9.0		
Hip Circumference	20 - 30	27	105.50	11.0	2.780	0.067
	31 - 40	38	103.47	5.9		
	41 - 50	35	108.31	9.5		
	Total	100	105.71	8.9		
W/H Ratio	20 - 30	26	0.87	0.1	0.453	0.637
	31 - 40	38	0.88	0.1		
	41 - 50	35	0.88	0.1		
	Total	99	0.88	0.1		
Mid Arm Circumference	20 - 30	27	32.01	3.2	1.351	0.264
	31 - 40	38	30.79	2.5		
	41 - 50	35	31.48	3.4		
	Total	100	31.36	3.0		

	Age	N	Mean	Std. Deviation	F-value	p-value
BMR	20 - 30	27	1475.07	178.1	8.38**	0.000
	31 - 40	38	1312.47	107.4		
	41 - 50	35	1357.80	190.1		
	Total	100	1372.24	171.4		

* Significant at 5% level, ** significant at 1% level

Table 2: Age – wise distribution of the sample according to their BMI

Age (Yrs)	BMI			Total	Chi Square	P-Value
	Not Obese- <25	Grade-I 25-29.9	Grade-II- 30-40			
20 - 30	3	16	8	27	11.20*	0.024
	(11.1%)	(59.3%)	(29.6%)	(100.0%)		
31 - 40	1	27	10	38		
	(2.6%)	(71.1%)	(26.3%)	(100.0%)		
41 - 50	4	12	19	35		
	(11.4%)	(34.3%)	(54.3%)	(100.0%)		
Total	8	55	37	100		
	(8.0%)	(55.0%)	(37.0%)	(100.0%)		

Source: Srilakshmi, (2011)
( ) – Numbers in paranthesis represent percentage.

Remaining 59.3% in 20 – 30 years, 71.1% are in 31 – 40 years and 34.3% in 41 – 50 years age group are classified under Grade-I obese. There is a significant association between age group and Body Mass Index(fig-1). Many studies are also reported that relationship between age group and BMI.

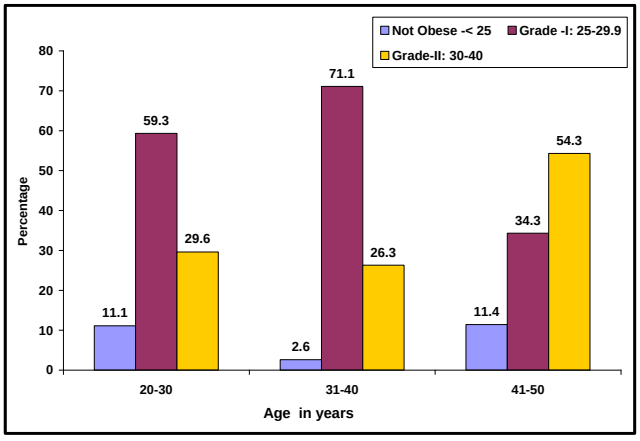

Fig. 1: Age wise distribution of the sample according to their BMI

Rufus *etal.* (2008) showed that the relative risks of developing hypertension among compared with the underweight, normal weight and overweight persons. Females with obesity had a risk of hypertension three times that of a normal weight female based on BMI.

Table 3 -Age – wise distribution of the sample according to waist-to-hip Ratio

Age (Yrs)	W/H Ratio		Total	Chi Square	P-Value
	<0.85	>0.85			
20 - 30	14	13	27	3.723	0.155
	(51.9%)	(48.1%)	(100.0%)		
31 – 40	11	27	38		
	(28.9%)	(71.1%)	(100.0%)		
41 - 50	12	23	35		
	(34.3%)	(65.7%)	(100.0%)		
Total	37	63	100		
	(37.0%)	(63.0%)	(100.0%)		

Source: Srilakshmi, (2011)
( ) – Numbers in paranthesis represent percentage.

Waist-to-hip ratio has been classified basing on their age as <0.85 and >0.85 range. As the age progresses majority of the percent 71.1% in 31 – 40 years are in >0.85 waist-to-hip ratio followed by 65.7% in 41 – 50 years and 48.1% in 20 – 30 years are in >0.85 waist-in-hip ratio range. Minimum percent observed to be >0.85 range (i.e. 34.3% in 41 – 50 years, 51.9% in 20 – 30 years 28.9% in 31 – 40 years). No significant association observed between age and waist-to-hip ratio. Shibili and Nasreen (2014) study showed that waist-to-hip ratio does not have any influence on performance. Waist-to-hip ratio can be considered as a health indicator than a performance indicator.

Table 4 -Age – wise distribution of the sample according to the waist circumference

Age (Yrs)	Waist Circumference		Total	Chi Square	P-Value
	<88 CM	>88 CM			
20 - 30	11	16	27	1.597	0.450
	(40.7%)	(59.3%)	(100.0%)		
31 – 40	13	25	38		
	(34.2%)	(65.8%)	(100.0%)		
41 - 50	9	26	35		
	(25.7%)	(74.3%)	(100.0%)		
Total	33	67	100		
	(33.0%)	(67.0%)	(100.0%)		

Source: Srilakshmi, (2011)
( ) – Numbers in paranthesis represent percentage.

The subjects were distributed according to their waist circumference basing on their age. Majority (67%), subjects were having above >88cm of waist circumference, it shows they were under the risk of other metabolic diseases. Around 33% subjects were having <88cm waist circumference.

Annesa (2003) showed that WC, a measure of central obesity, showed a significant association with the risk of having high BP in both sexes. Boys and girls in the uppermost tertile of WC were approximately seven times as likely as those in the lowest tertile of this measurement to have elevated B.P. WHR showed a statistically significant relationship with risk of high BP status in the female subjects only. Louise et al (2014) showed that anthropometric measurements of obesity were positively correlated with age. Measures of central obesity that included a measure of WC (WHR and WSR) generally recorded better correlation compared with measures of general obesity (BMI and BAI).

Table 5- Age – wise distribution of the sample according to their Body Fat

Age (Yrs)	Body Fat			Total	Chi Square	P-Value
	Normal 20-30%	31-33%	>33%			
20 - 30	1	2	24	27	5.267	0.229
	(3.7%)	(7.4%)	(88.9%)	100.0%		
31 – 40	0	3	35	38		
	(0.0%)	(7.9%)	(92.1%)	(100.0%)		
41 - 50	0	0	35	35		
	(0.0%)	(0.0%)	(100.0%)	(100.0%)		
Total	1	5	94	100		
	(1.0%)	(5.0%)	(94.0%)	(100.0%)		

Source: Srilakshmi, (2011)
( ) – Numbers in paranthesis represent percentage.

Table 6 - Age – wise distribution of the sample according to Body type

Age (Yrs)	Type of Body		Total	Chi Square	P-Value
	Latest Obese	Obese			
20 - 30	6	21	27	0.744	0.689
	(22.2%)	(77.8%)	(100.0%)		
31 – 40	6	32	38		
	(15.8%)	(84.2%)	(100.0%)		
41 - 50	5	30	35		
	(14.3%)	(85.7%)	(100.0%)		
Total	17	83	100		
	(17.0%)	(83.0%)	(100.0%)		

Source: Srilakshmi, (2011)
( ) – Numbers in paranthesis represent percentage.

Table 7 -Correlation (r) between Body Fat and Anthropometric indicators of subjects

	Body Fat	**Triceps**	**Biceps**	**Chest**	**Suprailiac**	**Waist Circumference**	**Hip Circumference**	**W/H Ratio**	**Mid Arm Circumference**	**BMR**
Body Fat	1	0.455 (**)	0.599 (**)	0.489 (**)	0.499 (**)	0.547(**)	0.591(**)	0.031	0.434(**)	0.403 (**)
Triceps	0.455 (**)	1	0.704 (**)	0.468 (**)	0.585 (**)	0.367(**)	0.471(**)	-0.079	0.529(**)	0.386 (**)
Biceps	0.599 (**)	0.704 (**)	1	0.537 (**)	0.560 (**)	0.423(**)	0.521(**)	-0.049	0.528(**)	0.409 (**)
Chest	0.489 (**)	0.468 (**)	0.537 (**)	1	0.562 (**)	0.275(**)	0.353(**)	-0.047	0.280(**)	0.367 (**)
Suprailiac	0.499 (**)	0.585 (**)	0.560 (**)	0.562 (**)	1	0.343(**)	0.397(**)	-0.009	0.372(**)	0.383 (**)
Waist Circumference	0.547 (**)	0.367 (**)	0.423 (**)	0.275 (**)	0.343 (**)	1	0.677(**)	0.508 (**)	0.538(**)	0.400 (**)
Hip Circumference	0.591(**)	0.471(**)	0.521 (**)	0.353 (**)	0.397 (**)	0.677(**)	1	-0.208(**)	0.754(**)	0.540 (**)
W/H Ratio	0.031	-0.079	-0.049	-0.047	-0.009	0.508(**)	-0.208(**)	1	-0.14	-0.096
Mid Arm Circumference	0.434(**)	0.529(**)	0.528(**)	0.280(**)	0.372(**)	0.538(**)	0.754(**)	-0.14	1	0.50 (**)
BMR	0.403(**)	0.386(**)	0.409(**)	0.367(**)	0.383(**)	0.400(**)	0.540(**)	-0.096	0.508(**)	1

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

The age of the subjects based on their body fat percentage are given in the table.

From the present study, it is very clear that 94% of the participated subjects were having >33% of body fat. This reveals the maximum number of subjects were having above >33% of fat that does mean that they are obese. Around 5% of the participated subjects were having 31 – 33% body fat and only 1% has normal body fat range between 20-30%. Chi-square test did not reveal significant association between age and body fat (fig-2).

Shibili and Nasreen (2014) study showed that there was a correlation exist between some of the anthropometric variables (e.g. : muscle mass, percentage of fat, girth measurement) with functional performance at the same time there was no correlation exist between some of anthropometric variables (e.g. BMI, waist-to-hip ratio) with functional performance.

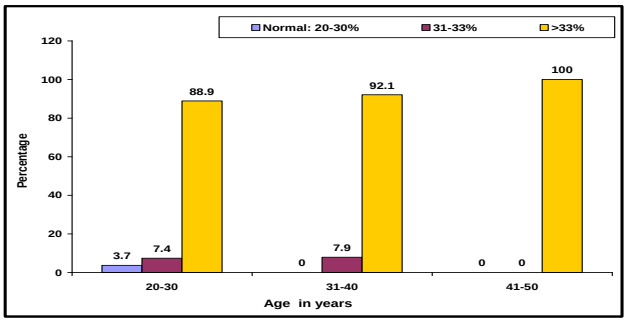

Fig. 2: Age wise distribution of the sample according to their body fat

Body type has been classified basing on their age as latent obese and obese. As the age progresses majority of the percent 84.2% in 31 – 40 years and 88.7% in 41 – 50 years and 77.8% in 20 – 30 years are obese. Minimum percent observed to be latent obese (i.e. 22.2% in 20 – 30 years, 15.8% in 31 – 40 years and 14.3% in 41 – 50 years). No significant association observed between age and body type (fig-3).

Yousef (2010) and Nazni *et.al*, (2010) showed that according to age – adjusted partial correlation among the anthropometric indices, BMI, WC and WHR were moderately to strongly inter correlated in men and women. BMI and WHR were weakly correlated, especially among women.

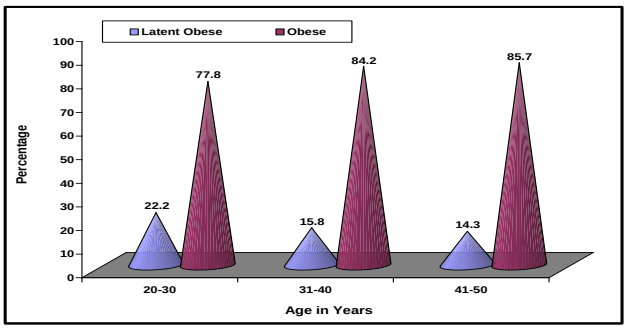

Fig.3: Age wise distribution of the sample according to body type

CORRELATION (R) BETWEEN BODY FAT AND ANTHROPOMETRIC INDICATORS OF SUBJECTS

Table reveals that many of body measurements showed significant correlation with body fat. Among them body fat had a positive and significant relation with Triceps, Biceps, Chest, Suprailiac, Waist Circumference, Hip Circumference, Mid Arm Circumference and BMI, whereas waist-to-hip ratio had shown no significant correlation with the body fat and other body measurements. Raja and Kaushik (2008) showed that, BMI, WC had strongest significant impact on these two measures compared with WHR and CI. It is also worth mentioning that these relationships did not differ across the age groups.

Smita Kumari (2012) and Nazni *et.al.,* (2013) reported in her that there were significant differences in the gender-adjusted BMI and WHR between diabetic subjects and controls was observed. Norgon (1994) have shown that BMI correlates highly with percentage of body fat and is largely independent of height, enabling an unbiased comparison between short and tall population groups. It should, however, be kept in mind that BMI is no more than weight adjusted for height, and that BMI is also related to fat free mass and to a lesser extent, also to body build.

CONCLUSION

Results from the present investigation revealed that though there is significant association observed between age group and Body Mass Index. It was observed that no significant association observed between age-waist-to-hip ratio, age-waist circumference, age-body fat and age body type. Hence, it is evident that body fat had a positive and significant relationship with triceps, biceps, chest, suprailiac, waist circumference, hip circumference, mid upper arm circumference and BMR. No significant correlation with the body fat and waist-to-hip ratio.

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