International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Anthropometric Indicators of Obesity and Percent Body Fat – A Measure for Weight Management

A. Soni[1], V. Verma[2]

[1] Ph.D Scholar, Department of Food and Nutrition, Govt. D. B. Girls P. G. College, Raipur Chhattisgarh, India.

[2] Professor, Departments of Food and Nutrition, Govt. D. B. Girls P. G. College, Raipur 492001, Chhattisgarh, India.

Abstract: ***Obesity, along with other unhealthy living habits, nowadays represents one of the greatest risk factors for various diseases. This study was designed to define the most suitable anthropometric technique among body mass index (BMI), waist-hip ratio (WHR) and Body fat percent (BF) as indices of obesity in women living in Raipur City. The study was a cross-sectional design. A selected sample of 70 females aged 25-50 years participated in a detailed height and weight measurement were taken using standard methodology and body fat percent estimated by bio - electrical impendence analysis (BIA). Data was analyzed using statistical package program. The most common methods for diagnosing overweight and obesity are based on BMI (kg/m2). However, BMI is suboptimal marker for total body fat percentage and even less suitable to assess body fat distribution. WHR is the most useful measure of obesity and the best simple anthropometric index in predicting a wide range of risk factors and related health conditions.***

Keywords: Anthropometry, Obesity, BMI, Waist-hip-ratio, Body fat percent.

1. Introduction

Anthropometry is one of the most basic classification for assessing nutritional status, whether over nutrition or under nutrition. A variety of methods are available to measure body fatness and body thinness. The most frequently used tools in public health evaluations and clinical screening are anthropometric-based measurements such as skin fold-thickness or circumference measurements or various height- and weight-based indexes such as weight-for-height, body mass index [wt (kg)/ht (m2)] [1]. WHO Expert Consultation (2004) decided to retain the universal BMI cut-off points of 25 kg/m2 for overweight and 30 kg/ m2 for obesity [2]. However, waist circumference (WC) and waist-hip ratio (WHR) are useful in predicting health outcomes and innovative measurement of body fat or obesity. Previously WHR was used for assessment for abdominal fat but now a days it id shifted to WC [3-4]. Several studies in adults have reported a strong positive association between cardiovascular risk factors such as hypertension, lipid and glucose concentrations and abdominal adiposity (measured by WC and WHR) than overall adiposity (measured by BMI) [5-6].Although high BMI has also been reported as being one of the most important risk factors for type 2 diabetes [7-8]. Thus, measurements of waist circumference (WC) and waist-hip ratio (WHR) have been viewed as alternatives to BMI, with both measures regularly used in the clinical and research settings. Waist circumference has been shown to be the best simple measure of both intra-abdominal fat mass and total fat [9]. The rising prevalence of overweight and obesity need for accurate method of assessment of obesity. Currently, there are many measures for diagnosing obesity at population level but most frequently used diagnostic tool in the current classification system of obesity is body mass index. It was confirmed by various scientist [10-11] that the use of BMI as a measure obesity can introduce misclassification problem because it does not provide information about the respective contributions of fat mass and fat free mass to body weight. However, it is difficult to accurately measure body fat mass, because this requires new technologies that are available. It seems that true body fatness may be better evaluated by assessment of body fat and fat-free mass [12]. Therefore, much research has recently examined the believable role of body composition measurements [13-12-14]. Until now, bioelectrical impedance analysis (BIA) has been considered as the simplest, most reliable and low cost method for body composition evaluation in clinical practice, and it showed high accuracy and excellent correlation with dual-energy X-ray absorptiometry (DXA) in assessing BF%[15-16] Therefore, BIA is considered the most cost-effective and possible replacement for DXA in assessing body composition. BF% has been most commonly used in practice. However, the accuracy of BF% measurements is dependent on height and cannot be evaluated independently from fat free mass [17].

Obesity is a recognized major risk factor for the development of atherosclerotic, osteoarthritis and major cardio vascular metabolic risk factor all independently with both body mass index and waist hip ratio and improves with weight loss. Waist circumference relates closely to BMI, gives the best assessment of intra- abdominal fat as opposed to subcutaneous fat and is dominate determinant in WHR. Waist circumference is also the indicator of changes in intra abdominal fat during weight loss. It is suggested that waist circumference ≥80 cm in males and ≥72 cm in females are at risk from either increased body weight or central fat distribution or both. The objective to the study was to estimate the subjects above 25 years in urban area of Raipur city.

2. Materials and Methods

The present cross - sectional study was taken to assess the prevalence of obesity among 70 females between the age groups of age 25 to 50 years .The study was carried out in Raipur city Chhattisgarh. All the subjects were apparently healthy, without any signs and symptoms of physical abnormality. Only those subjects who gave written consent

Licensed Under Creative Commons Attribution CC BY

were included in this study. Personal information about age, demographic profile, dietary pattern and activity level were collected through a well designed pre tested questionnaire. Pregnant, Diabetic, and patient with chronic renal failure, hypothyroid were excluded from this study. Each subject was contacted personally at their residence.

The study protocol was approved by the Institution Ethical Review Committee of the Department of Home Science. The subject were lightly dressed and without shoes and were measured in the morning hours. Body height measured with an anthrop meter in the standing erect position, to the nearest 0.1cm. Body weight was measured on electronic digital scale with an accuracy of up to 0.1 kg. Waist circumference was measured to the nearest 1mm at the level midway between the lower rib margin and the iliac crest at end of normal expiration. Hip circumference was represents maximum posterior extension of buttocks and was measured to the nearest 1 mm at the widest point between hip and buttock. All anthropometric measurements height, weight and WHR were taken by standard techniques.

Percent body fat was estimated by bio-electrical impendence analysis (BIA) technique using. BIA involves passage of a very weak alternating current across the foot and thumb. As mentioned in instructions of the equipment, right hand and foot was selected for experiment. BIA is based upon the principle that electric current flows through body at different rates depending upon its composition.

The assessment of obesity was carried out by using BMI and PBF. BMI was calculated from measured values of height and weight for each subject. In general, BMI=weight (kg)/height (m^2) for the assessment of overweight and obesity following BMI criteria of WHO (2000) used.

Nutritional status	*WHO criteria BMI cut -off*
Underweight	<18.5
Normal	18.5 -24.9
Overweight	25 -29.9
Pre-Obese	-
Obese	>30
Obese Type 1 (obese)	30 -40
Obese Type 2 (morbid obese)	40.1 -50
Obese Type 3 (super obese)	>50

Waist Circumference of subjects was classified according to WHO as waist circumference ≤80cm normal; between 80-88 cm –increased susceptibility to metabolic complications and above 88 cm- high risk for metabolic complications. Similarly, PBF was used for assessment of overweight and obesity by using criteria according to WHO, females having percent bf above 30 were considered obese and those having per cent BF below or equal to 30 as normal.

2.1 Statistical Analysis

The Statistical Analysis of data was entered into the computer using MS-Excel program. Mean and Standard deviations for various parameters was computed.

3. Results

Mean age of sample was 37 years. They all belonged to upper middle income group and followed a sedentary pattern of life style.

Table 1 shows the basic characteristics of the studied sample .it is apparent from this table that there is wide variation in minimum and maximum values of the studies.

Table 1: Basic characteristics of the females

Variables	Mean N=70	SD	Minimum value	Maximum value
Age (yrs.)	37.5	11.93	25	50
Height (cm)	155.42	4.09	150	159
Weight (kg)	68.14	14.29	45	98
BMI (kg/m^2)	28.16	5.62	18.5	37.1
WHR	0.88	0.11	0.65	1.09
Percent body fat	38.35	10.3	19.3	50.5

Table 2 showed that 38 percent subjects had BMI between 30 to 40 with mean 33.9± 1.87 and 30 percent of subject had percent of BMI between 25- 30 with 27.19 ± 1.18 while 27 percent 20-25 and 7 percent 18.5-20 of subjects had mean BMI 23.79 ± 1.01 and 19.36 ± 0.46 respectively.

Table 2: BMI, Percentage of the females

BMI	*Number of subjects*	*Percentage*	*Mean ± SD*
30-40	25	38%	33.90±1.87
25-30	21	30%	27.19±1.18
20-25	19	27%	23.79±1.01
18.5-20	5	7%	19.36±0.46

3.1 Percent of Body Fat

According to percent BF as who classification 70 percent of subjects were found to have high percent BF with mean 40.78 ±6.94 while only 30 percent of subject had normal percent BF below 30 with mean 23.31 ±3.30.

3.2 BMI and percent body fat

Table 3 body mass index and percentage of body fat of Subject who were overweight (BMI: 25-30) had mean percent BF 39.02 ± 3.86 while obese BMI ((30-40) had mean percent BF 46.07 ± 3.53. subjects who came in normal category according to BMI had mean percent BF 23.98 ± 1.30. On the other hand subjects whose BMI range was 18.5-20 had mean percent BF 21.36 ± 2.25 results show that in every category of BMI subjects had some higher percent body fat but as the BMI increased their mean percent BF also increased. Only 34.28 percent of subjects had normal BMI and High percent BF. Thirty five percent subjects had high BMI with very High BF.

Table 3: Body mass index and percentage of body fat among females

BMI	*Number of subjects* N= 70	*Mean and standard deviation percent BF*
30-40	25	46.07 ± 3.53
25-30	21	39.02 ± 3.86
20-25	19	23.98 ± 1.30
18.5-20	5	21.36 ± 2.25

Licensed Under Creative Commons Attribution CC BY

3.4 Waist –Hip Ratio

Table 4. Only 11.24 percent subjects had WHR below 0.7 with mean WHR 0.67 ± 0.01 while 28.57 percent had normal WHR with 0.80 ± 0.02.while 60 percent subjects were found to be occupied for metabolic complication with mean WHR 0.96 ± 0.15.

Table 4: WHR, percentage of the females

WHR	*Number of Subjects (N= 70)*	*Percentage*	*Mean ± SD*
> 0.85	42	60%	0.96 ± 0.15
0.7-0.85	20	28.57%	0.80 ± 0.02
< 0.7	8	11.42%	0.67 ± 0.01

3.5 Waist –Hip Ratio and percent of body fat

Table 5 Mean percent body fat for female with WHR below 0.7 was 28.62 ± 1.57.Females who were normal according to WHR had mean percent BF 33.26 ± 2.89.while those with abdominal obesity had mean percent BF 44 .00 ± 3.78. Thus it was analyzed that as WHR increased mean percent BF also increased.

Most of the subjects (42) 60 percent had above 0.85 WHR and also high percent BF while no subjects had high WHR and low percent BF. It was found that 21.4 percent so females (15) had high WHR and high percent BF while 18.5 percent of females had normal WHR and low percent BF. so it is showed that Indian not only have normal BMI and high percent BF but also may have normal WHR and high percent BF.

Table 5: Waist Hip Ratio and percentage of body fat among females

WHR	*Number of subjects* N= 70	*Mean and standard deviation percent BF*
> 0.85	42	44 .00 ± 3.78
0.7-0.85	20	33.26 ± 2.89
< 0.7	8	28.62 ± 1.57

4. Discussion

The data reported here suggested that there is a progressive increase in weight, and therefore in BMI, in women up to 50 years of age, with women with a higher mean of BMI. The increase is particularly in the 20–29 years of age, amounting to 6–7 kg in women. The reason may be due to expansiveness of WHR including android type of obesity.

A central distribution of body fat, indicated by a high WHR, has been shown to be associated with other risk factors, many chronic diseases (e.g., hypertension, cardiovascular disease, non-insulin-dependent diabetes, and stroke) and mortality [18].
In many countries, Higher education also means a certain life style which influences physical and health status. The level of education also influences BMI and WHR values which is particularly observable in females. Better educated women show markedly lower values of the above indexes [19]

The size of intra – abdominal fat tissue, central obesity, defined as the waist and hip ratio (WHR), is an important factor for indicting predisposition for cardiovascular and metabolic disorders [20].

There are two types of obesity according to body shape pear shape and apple shape .pear shape is associated with the accumulation of fat in pelvis, thighs and gluteal region. In relation to the health risk, apple shape, central obesity, characterized by fat accumulation in shoulders and upper abdomen, appears to bring more risk. Individuals with this body shape are at greater risk of developing a metabolic, cardiovascular or malignant disorder [21].

More recently, it has been argued that WC alone might convey equally valid information as WHR and BMI in measuring abdominal fat and be at least as strongly associated as with other risk factors [22-23]. If this were the case, the use of this single measurement would simplify the interpretation of epidemiological data as well as the public health recommendations relating to weight management [24] Suggested the degree of fatness and overweight do not fit in the same criteria, but with our research and analysis we found out that contradicting result that BMI was a relatively good predictor to examine the level of body fat. It is important to remember that although BMI correlates with the amount of body fat, they vary parallel and in uniform way. It forgoing analysis associated with greater mean levels of body fat is more in women as compare to men's and proceed towards increment. BMI cut points for clinical risk assessment due to the marked difference in the BMI-per cent fat relation observed in men and women across the entire range of BMI. BMI is just one indicator of potential health risks associated with being overweight or obese. For assessing someone's likelihood of developing overweight- or obesity-related diseases, [25-26] shows the result that, atherosclerosis and diabetes patient are more in greater risk factor as they consume excess of body fat rather than body weight. This was relatively straightforwardly suggested to measure body fat directly to get the precise result on labels overweight and obesity.

The best evidence was provided by Hwu et al [26] who found that postmenopausal Chinese women with abdominal obesity carried a higher metabolic and cardiovascular risk than those without obesity and that it was the WC rather than the BMI that predicted the risk in those women. Although the BMI may be below 25, visceral fat may be increased; thus WC becomes particularly important with people whose BMI is between 22 and 29 [27]. In a comparison of the utility of various anthropometric measures in identifying CVD risk factors in a Hong Kong population, found that BMI and WC proved most effective for men, while WC and WHR were preferable for women [26]. Waist circumference may provide a useful index reflecting general and central obesity. In order to identify true differences between the three techniques in their ability to identify individuals at greatest risk of CVD, a standardized method of comparison needs to be used, rather than the conventionally used arbitrary cut-off points for obesity. For this reason, the risk of diabetes, hypertension and dyslipidaemia by obesity status is based on quartiles of BMI, BF and WHR. Numerous techniques have been used to estimate body composition. None of the methods currently used actually measure %BF; the only way to truly measure the volume of fat in the body

Licensed Under Creative Commons Attribution CC BY

is BIA some methods are incredibly inaccurate to measure, so one need to adopt that method which give precise result to find BMI AND Body Fat%, it is a relatively accurate and inexpensive method, about the reliability BIA derived estimates of body composition at the extremes of body fat distribution. Clearly, in the present study we were confronted with erroneous estimates of body fat among extremely lean individuals in the Nigerian and Jamaican samples .Some investigators have raised concerns about the use of BIA in epidemiologic research [28-29] requirements for the standardization of protocols [30] profusion of predictive equations in the literature[28] and inconsistencies between analyzers from different manufacturers[31].We believe it is currently the best option for measuring body composition in the field. Knowing these characteristics will help you decide wisely when choosing the method for body composition assessment.

5. Conclusion

In conclusion, our finding show that body fat were found to be higher in female subjects and 70 percent of subjects had body fat more than 30 percent. According to BMI 66 percent subjects were found to be overweight and obese subjects were having lower range increased the percent BF of subjects also increased. Central obesity is more present in females. A higher waist Hip Ratio is observed in 60% of females with the risk value (females≥88 cm).The indices of obesity indicate a potential health risk for more than a half of the subjects in this study. BMI and WHR is simple to assess, it can be predicting a wide range of risk factors and related health conditions. The data therefore point to the necessity of introducing educational programs for promoting good nutrition and healthy living habits that would ultimately reduce the number of individuals with health risk.

6. Limitation

It should be noted that this study has primarily concerned with the prevalence and anthropometric techniques of obesity and suffers from a number of limitations. First, the present study did not consider Pregnant, Diabetic, and patient with chronic metabolic disorder cardio vascular renal failure, hypothyroid patients excluded from this study. Second, as our aim in this study was to show only the prevalence and anthropometric techniques of obesity.

7. Acknowledgements

We wish to thank all the women who voluntarily took part in the study without whom this study and its finding would not be possible.

References

[1] World Health Organization. Physical status (1995) The use and interpretation of anthropometry. Report of a WHO Expert Committee. World Health Organ Tech Rep Ser., 854:1–452.
[2] WHO Expert Consultation (2004) Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies Lancet; 363:157 – 163.
[3] Lean, M.E.J., Han, T.S. and Sidell, J.C. (1998) Impairment of health and quality of life in people with large waist circumference. Lancet, 351, 853-856.
[4] Mei, Z.Strawn, LMG, Peitrobell, A. et al (2002) Body Mass Index, Am. J.clin. nutr. 75,978-985.
[5] Nooyens, C.J., Astrid, Koppes, L.J, et al (2007) Adolescent skin fold thickness is a better predictor of high body fatness in adults than is body mass index: the Amsterdam Growth and Health Longitudinal Study.Am J Clin Nutr June vol. 85 no. 6 1533-1539.
[6] Visscher T.L., Kromhout, D., Seidell J.C. (2006) Underreporting of BMI in Adults and Its Effect on Obesity Prevalence Estimations in the Period 1998 to 2001 Obesity Volume 14, Issue 11, pages 2054–2063.
[7] Ho S.C., Chen Y.M., Woo J.L., Leung S.S, et al (2001) Validity of body mass index and waist circumference in the classification of obesity as compared to percent body fat in Chinese middle-aged women Int J Obes Relat Metab Disord, 25 1689.
[8] Hartz, A., Rupley, D., Rimm, A. (1984) THE ASSOCIATION OF GIRTH MEASUREMENTS WITH DISEASE IN 32,856 WOMENAm J Epidemiol, 119, 71.
[9] Chan,J., Rimm,E, et al (1994) Obesity, Fat Distribution, and Weight Gain as Risk Factors for Clinical Diabetes in Men Diabetes Care, 17, 961.
[10] Lemieux, S., Bouchard, C, et al (1996) A single threshold value of waist girth identifies normal-weight and overweight subjects with excess visceral adipose tissue. Am J Clin Nutr, 64, 685.
[11] Lavie CJ, De Schutter A, Patel DA, Romero-Corral A, Artham SM, Milani RV.(2012) Body composition and survival in stable coronary heart disease-Impact of lean mass index and body fat in the "obesity paradox".J Am Coll Cardiol.; 60:1374-1380.
[12] Thibault R, Pichard C. (2012) The evaluation of body composition: a useful tool for clinical practice. Ann Nutr Metab.; 60:6-16.
[13] Zeng Q, Dong SY, Sun XN, Xie J, Cui Y. (2012) Percent body fat is a better predictor of cardiovascular risk factors than body mass index. Braz J Med Biol Res.; 45:591-600.
[14] Bintvibok W, Cbaikittisilpa S, Panyakamlerd K, Jaisamrarn U, Taecbakraicbana N. (2013) Cut-off value of body fat in association with metabolic syndrome in Thai peri- and postmenopausal women. Climacteric, 16:1-5.
[15] Jeong DLS, Min H, Kim Y, Choi S, Kim Y. (2006) Measuring performance evaluation of body fat measuring instrument applying body measuring value method. Korean J Health Promot Dis Prev.; 6:79-87
[16] Xu L, Cheng X, Wang J, Cao Q, Sato T, Wang M, et al (2011) Comparisons of body-composition prediction accuracy .A study of 2 bioelectric impedance consumer devices in healthy Chinese persons using DXA and MRI as criteria methods. J Clin Densitom.; 14:458-464.
[17] Björntorp, P. (1992) Abdominal Fat Distribution and Disease: An Overview of Epidemiological Data, Vol. 24, No. 1, Pages 15-18.

Licensed Under Creative Commons Attribution CC BY

[18] Pavlica T. (2009) Anthropometric Indices of Obesity and Potential Health Risk in Adult Rural Population from Bačka and Banat - Novi Sad University, Novi Sad, Serbia.
[19] Skrzypczak, M., Szwed, A. et al (2007) Assessment of the BMI, WHR and W/Ht in pre- and postmenopausal women. - Anthropological Review. Volume 70, Issue 1, Pages 3–13
[20] Stokić, E., Micić, D., & Jorga, J. (2004) Gojaznost je bolest koja se leči. Medicinski fakultet.Novi sad, p.139.
[21] Pouliot, M., C, DespresJ.,P, Lemieux, S. (1994) Waist circumference and abdominal sagittal diameter: Best simple anthropometric indexes of abdominal visceral adipose tissue accumulation and related cardiovascular risk in men and women Am J Cardiol, 73 460.—18.
[22] Han T., S, van leer E., M, Seidell J., C. (1995) Waist circumference action levels in the identification of cardiovascular risk factors: prevalence study in a random sample.LEAN MEJ, BMJ, 311 1401.
[23]. Hartz, A., Rupley, D., Rimm, A. (1984) The Association OF Girth Measurements with Disease in 32,856 WomenAm J Epidemiol, 119, 71.
[24] Borrelli R, Isernia C, Di Biasse G, Contaldo C. (1988) Mortality rate, causes and predictive factors of death in severely obese patients. Int J Vitam Nutr Res.; 58: 343–350.
[25] Paulson DJ, Tahiliani AG. (1992) Cardiovascular abnormalities associated with human and rodent obesity. Life Sci. 51: 1557–1569.
[26] Hwu C., M, Fuh J., L, Hsiao C., F. (2003) Waist circumference predicts metabolic cardiovascular risk in postmenopausal Chinese women Menopause, 10; 73.
[27] Bray G., A. (2003) Evaluation of obesity. Who are the obese? Postgrad Med, 114 (6):19-27, 38.
[28] Hammond J, Rona RJ, Chinn S. (1994) Estimation in community surveys of total body fat of children using bioelectrical impedance or skinfold thickness measurements. Eur J Clin Nutr.; 48:164-71.
[29] Deurenberg P, Snut HE, Kusters CS (1989) Is the bioelectncal impedance method suitable for epidemiological field studies? Eur J Chn Nutr.; 43:647-54.
[30] Gudivaka R, Schoeller D, Ho T, Spiegel D, Kushner R.(1994) Effect of body position, electrode placement and time on prediction of total body water by multifrequency bioelectrical impedance analysis Age Nutr.; 5:111-17.
[31] Smye SW, Sutchffe J, Pitt E. (1993) A comparison of four commercial systems used to measure whole-body electncal impedance. Physiol Meas.; 1447:3-8.

Author Profile

Arpita Soni received the M.Sc. in **Food and Nutrition**, from Govt. D. B. Girls P. G. College, Raipur in 2000. Pursuing in Ph. D. from Pt.Ravishanker Shukla University, Raipur. During 2003-2014 have been working as Dietician in Dietetics and Clinical Nutrition field now she is working as Chief Dietician in Shree Narayana Multi Specialty Hospital, Raipur, Chhattisgarh.

Licensed Under Creative Commons Attribution CC BY