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Medical Science

"IS WAIST CIRCUMFERENCE PROVE TO BE A BETTER TOOL TO ASCERTAIN THE MAGNITUDE OF OBESITY"

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ABSTRACT **Introduction:** Obesity is a natural consequence of over nutrition and sedentary lifestyle. In the developing countries, with the enhancement in economic status, there is an increase in the prevalence of obesity and metabolic syndrome is observed in adults and children. The main causes are increasing urbanization, nutrition transition, and reduced physical activity. Obesity is associated with many diseases that include cardiovascular diseases (CVDs), hypertension, hyperlipidemia, diabetes mellitus, colorectal cancer, breast cancer, and endometrial cancer.

Objectives:

1.To ascertain the prevalence of obesity among adults (>18 years of age) by Waist Circumference (WC), Waist-Hip Ratio (WHR) and Body Mass Index (BMI).

2. To study the socio-demographic attributes of the study population.

Method: The present cross-sectional study was conducted among 589 adults aged 18 years and above in the field practice area of the UHTC of department of Community Medicine, Subharti Medical College, Meerut, with the aims and objectives to ascertain the magnitude of overweight & obesity among adults and to study the relationship of various socio-demographic characteristics with overweight & obesity. **Study Design:** Community-based cross-sectional study.Setting and Participants: All adults from the catchment area of the UHTC of the department of community medicine, Subharti Medical College, Meerut. Sample size: 589.Sampling technique: Simple Random Sampling.Study Instruments: Pre-designed, pre-tested and semi-structured interview schedule, Shorr's height board, Digital weighing machine and Non-stretchable fiber measuring tape.Statistical Methods: Pearson's Chi square test and ANOVA-F test. **Results:** The prevalence of obesity by BMI, waist-hip ratio and waist circumference in the current study came out to be 13.4%, 47.0% and 39.7% respectively. Among the various socio-demographic characteristics studied; age, gender, education, occupation, socio-economic and marital status were found to be statistically significant.($p < 0.05$)

KEYWORDS : Adults, Obesity, Waist Circumference (WC), Waist-Hip Ratio (WHR) and Body Mass Index (BMI), Socio-demographic profile, Socio-economic status

INTRODUCTION:

Obesity is a chronic and stigmatizing medical condition that has become a major health problem in most industrialized countries because of its high prevalence, causal relationship with serious medical illnesses, and economic impact. Indian Asians have a high prevalence of the metabolic syndrome compared with Europeans and it seems to be highly heritable.[1]

In most of the countries, about 20-30% of the adult population is amenable to metabolic syndrome. In Asian Indians while dealing with metabolic syndrome, clinicians consider obesity measures, metabolic profiles and dietary fatty acids simultaneously[2].

The term obesity, describe body weight which is much greater than what is normal or healthy. An obese person is one, having the body fat greater than normal. Unhealthy weight gain occurs when energy intake from food is greater than energy expended through physical activity. Environmental, cultural, genetic and lifestyle factors all contribute to overweight and obesity [3].

The world's underfed population has declined slightly since 1980 to 1.1 billion, the number of overweight people has surged to 1.9 billion with more than 650 million adults as obese in 2016[4]. India is in the midst of an obesity epidemic, which has serious health ramifications.

Obesity is often defined simply as a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent that health may be impaired[5]. Obesity can be viewed as the first wave of a defined cluster of NCDs called **"New World Syndrome,"** creating an enormous socio-economic and public health burden in poorer countries. Many developing countries[6] are confronted by a 'double burden' of malnutrition in which under-nutrition and obesity exist side-by-side within the same country, same community and, not infrequently, in the same household. This double burden is attributable to inadequate pre-natal, infant and child nutrition followed by exposure to high fat, energy-dense, micronutrient-deficient foods and lack of physical activity. There is, however, less empirical certainty on the socioeconomic patterning of the double nutritional burden within a country. The commonly held perspective is that before a nutritional transition, overweight and underweight tend to be concentrated in the high- and low-socioeconomic status groups, respectively. During the transition, however, the overweight burden is posited to shift to the low-SES groups, even though the underweight burden remains, which exposes the low-SES groups to a double nutritional burden.[6]

India too is gaining weight and is in the midst of an epidemiological transition. Some believe that overweight and obesity is not a problem in Indian context but various studies have shown the percentage of overweight urban people, as high as 45 in females and 30 in males.[7]Central obesity is an important predictor for metabolic perturbations and adverse health effects in adults.

There are very few community based studies available to know the exact prevalence of obesity in this region. So, with this scenario of health situation, it gives an edge to study the burden of overweight and obesity and its risk factors to know the real dimension of the problem and work towards the prevention and control of this epidemic.

Objectives:

- To ascertain the prevalence of obesity among adults (>18 years of age) by Waist Circumference (WC), Waist-Hip Ratio (WHR) and Body Mass Index (BMI).
- To study the socio-demographicattributes of the study population.

MATERIALS & METHODS:

The present cross-sectional study was conducted among 589 adults aged 18 years and above in the field practice area of the UHTC of department of Community Medicine, Subharti Medical College, Meerut, with the aims and objectives to ascertain the magnitude of overweight & obesity among adults and to study the relationship of

various socio-demographic characteristics with overweight & obesity. Among 2112 registered families, a total of 589 adults were studied using simple random sampling technique. Out of them, 306 (52.0%) were males and 283 (48.0%) were females. Detailed information was collected on a pre-designed, pre-tested, semi-structured schedule about the socio-demographic characteristics for overweight and obesity by oral questionnaire method, supplemented by anthropometric examination for weight, height, waist and hip circumference.

The period of study was from December2019 to August 2020 which was used for development of study tools, data collection, analysis, compilation and presentation of findings.Prevalence of over-weight and obesity in India is 36.3% [8]considering relative error of 4%, the minimum sample size calculated came out to be 555.

Approval from the Institutional Ethical Committee was obtained.Informed written consent was obtained from each participant after explaining them about the study.

All the adults of both the sex, who had completed ≥18 years of age at the time of data collection and residing in the study area, that is, urban area of Meerut District from the selected families, were included in the sampling universe.

Selection of Study Participants:

Sampling Unit:

Sampling unit was the family in the study area. Family is defined as a group of individuals who are related by blood or marriage or adoption, living under the same roof, sharing a common kitchen and family purse.[9]

Sampling technique: Simple Random Sampling.

Tools of data collection:

- **Semi-structured and pretested interview schedule**

Shorr's height board-

For measurement of height.Height was measured with the help of Shorr's height measuring board. After placing the board on a hard, flat surface the subject was asked to take off his/her shoes, stand on the base of board and to face forward. Mid-axillary line was perpendicular to the base of height board where subject was standing. Subject was asked to look straight ahead and head was positioned so that the line of sight was parallel to the ground to avoid the error of parallax. Subject's shoulders were at level, hands were at the side and buttocks touched the back of measuring board. After the correct positioning, headpiece was lowered on top of the head and measurement was taken to the nearest 0.1 cm. It was recorded in centimeters and then converted to meters for calculating BMI.

Digital weighing machine-

For measurement of weight.Weight was measured with the electronic weighing scale (uniscale) manufactured for UNICEF by Seca corporation, Munich, Germany. It was a solar powered digital scale which was standardized every week with standard weights. The subjects were asked to wear light clothing. Weight was taken with the subject standing motionless without support on the weighing scale in minimum clothing, without shoes and weight equally distributed on each leg. It was measured to the nearest 100 gm.[10]

Non-stretchable fiber measuring tape-

For measurement of waist and hip circumference.

WC was measured at the level halfway between the iliac crest and the costal margin in the mid-axillary line. The landmarks were located by palpation, and the midpoint found using a tape measure. The measurement was taken at the end of a normal expiration with the arms relaxed at the sides and the subject in standing position.

The cut-off used for WC is as follows-[11]

Males:> 102 cm

Females:>88 cm

- Hip circumference was measured at the level of greater trochanters with the subject in standing position and both feet together.[12]

The cut-off used for WHR is as follows-[13]

Males: > 1

Females: > 0.85

* Two consecutive readings were made for each site to the nearest 0.5cm on a horizontal plane without compression of skin. The mean of two set of values was used.

Statistical Methods:

Data was analyzed using appropriate statistical tests by Systat 13.2 and Epi-info version 3.5.3 software. For proportions, Pearson's Chi square test was applied to find out significant association between independent and dependent variables.

For all the tests, a p-value of less than 0.05 was considered significant whereas a value of than 0.001 was considered highly significant. Wherever the expected cell frequency was less than 5, Fisher's exact test value was considered. All the statistical significance was evaluated at 95% level.

The results were transferred to pre-designed classified tables prepared according to the aims and objectives of the study. Valid inferences were drawn from the information and the results were thoroughly discussed and compared with the available studies conducted in the same field.

RESULTS:

Table I: Prevalence of Obesity according to WC & WHR:

WC	Male (n=306)		Female (n=283)		Total (N=589)	
	No.	%	No.	%	No.	%
Normal	221	72.2	134	47.3	355	60.3
Obese	85	27.8	149	52.7	234	39.7
Total	306	100.0	283	100.0	589	100.0
WHR	Male (n=306)		Female (n=283)		Total (N=589)	
	No.	%	No.	%	No.	%
Normal	203	66.3	109	38.5	312	53.0
Obese	103	33.7	174	61.5	277	47.0
Total	306	100.0	283	100.0	589	100.0

*** WC:** Waist circumference; **WHR:** Waist-Hip ratio.

Table II: Prevalence of Obesity according to BMI:

BMI (in Kg/m2)		Male (n=306)		Female (n=283)		Total (N=589)	
		No.	%	No.	%	No.	%
Underweight (<18.5)		17	5.6	29	10.2	46	7.8
Normal (18.5-24.99)		177	57.8	135	47.7	312	53.0
Overweight (25-29.99)		84	27.5	68	24.0	152	37.4
OBESITY (≥30)	Obese Class I (30-34.99)	28	9.0	51	18.0	79	13.4
	Obese Class II (35-39.99)	5	1.6	9	3.2	14	2.4
	Obese Class III (≥40)	1	0.3	3	1.1	4	0.7
Total		306	100.0	283	100.0	589	100.0

Table III: Analysis of Variance of WC with BMI and WHR:

		Sum of Squares	Df	Mean Square	F	p-value
WHR	Between Groups	44.438	1	44.438	452.439	0.001
	Within Groups	34.672	305	0.098		
	Total	79.110	306			
BMI	Between Groups	113.835	1	113.835	376.862	0.001
	Within Groups	106.627	305	0.302		
	Total	220.462	306			

The application of one-way ANOVA between WC & WHR and WC & BMI shows a high significant difference at 5% level of significance for WHR & BMI respectively.

Table IV: Association of Prevalence of obesity with Age :

Age group (years)	Male (n=306)		Female (n=283)		Total (N=589)	
	Normal	Obese	Normal	Obese	Normal	Obese
	No.	No.	No.	No.	No.	No.
	%	%	%	%	%	%
18-25	93	4	58	15	151	19
	95.9%	4.1%	79.5%	20.5%	88.8%	11.2%
26-33	33	20	33	28	66	48
	62.3%	37.7%	54.1%	45.9%	57.9%	42.1%
34-41	33	24	19	30	52	54
	57.9%	42.1%	38.8%	61.2%	49.1%	50.9%
42-49	21	12	6	22	27	34
	63.6%	36.4%	21.4%	78.6%	44.3%	55.7%
50-57	18	7	4	24	22	31
	72.0%	28.0%	14.3%	85.7%	41.5%	58.5%
58-65	14	9	6	20	20	29
	60.9%	39.1%	23.1%	76.9%	40.8%	59.2%
>65	10	8	8	10	18	18
	55.6%	44.4%	44.4%	55.6%	50.0%	50.0%
Total	222	84	134	149	356	233
	72.5%	27.5%	47.3%	52.7%	60.4%	39.6%
Test of Significance	$\chi2$ value= 40.97 df= 6 p value< 0.0001		$\chi2$ value= 58.767 df=6 p value< 0.0001		$\chi2$ for trend= 87.487 p value< 0.0001	

Table V: Association of Prevalence of Obesity with Sex

Gender	Total (N=589)			
	Normal (n=356)		Obese (n=233)	
	No.	%	No.	%
Male	222	72.5	84	27.5
Female	134	47.3	149	52.7
Test of Significance	$\chi2$ value= 39.0473, df= 1,p-value<0.00001			

Table VI: Association of Prevalence of Obesity with Socio-economic status:

Socio-economic status	Male (n=306)		Female (n=283)		Total (N=589)	
	Normal	Obese	Normal	Obese	Normal	Obese
	N	N	N	N	N	N
	%	%	%	%	%	%
Upper Class (I)	18	10	11	17	29	27
	63.6%	36.4%	39.4%	60.6%	51.8%	48.2%
Upper Middle(II)	146	62	89	95	235	157
	70.2%	29.8%	48.4%	51.6%	59.9%	40.1%
Lower Middle(III)	48	9	24	32	72	41
	84.2%	15.8%	42.9%	57.1%	63.7%	36.3%
Upper Lower (IV)	10	3	10	5	20	8
	76.9%	23.1%	66.7%	33.3%	71.4%	28.6%
Total	222	84	134	149	356	233
	72.5%	27.5%	47.3%	52.7%	60.4%	39.6%
Test of Significance	$\chi2$ value=5.5572 df= 3 p-value= 0.135		$\chi2$ value=3.5057 df= 3 p-value= 0.32		$\chi2$ for trend=3.7152 p-value=0.2939	

Table VII: Association of Prevalence of Obesity with Marital status:

Marital status	Male (n=306)		Female (n=283)		Total (N=589)	
	Normal	Obese	Normal	Obese	Normal	Obese
	N	N	N	N	N	N
	%	%	%	%	%	%
Unmarried	86	6	44	8	130	14
	93.5%	6.5%	85.0%	15.0%	90.3%	9.7%
Married	127	75	83	121	210	196
	62.9%	37.1%	40.7%	59.3%	51.7%	48.3%
Divorced/ Separated	0	0	0	2	0	2
	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Widow/ Widower	7	3	9	18	16	21
	70.0%	30.0%	33.3%	66.7%	43.2%	56.8%
Total	222	84	134	149	356	233
	72.5%	27.5%	47.3%	52.7%	60.4%	39.6%
Test of Significance	$\chi2$ value=29.64 df= 2 p-value<0.0001		$\chi2$ value=36.484 df= 3 p-value= <0.0001		$\chi2$ value=74.15 df= 3 p-value <0.0001	

DISCUSSION:

The health risks associated with central fat distribution are now universally recognized than that of BMI [14].

The practical measurement of the body fat distribution parameters are nearly a half-century after the central fat risks are first reported. Waist-to-hip ratio is the most popular index for assessing central obesity [15].

As Asian Indians are predisposed to abdominal adiposity,[16] indices taking into account the latter are a better tool to ascertain the magnitude of obesity. Waist circumference (WC) is a convenient and simple measurement that is unrelated to height,[13] correlates closely with BMI and WHR[17]and is an approximate index of intra-abdominal fat mass[18] and total body fat. Moreover, the use of waist circumference may be justified due to the relative ease of obtaining waist circumference, which is at the same time more accurate than measuring height and weight.[11]Furthermore, it has a higher sensitivity than WHR, both for males and females.[11] Thus, for analyzing the associations statistically, waist circumference has been deployed as a criteria for assessing obesity in the current study.

The prevalence of overweight and obesity according to the WHO criteria for BMI is 25.8% and 13.4% respectively. The prevalence using waist circumference and waist-hip ratio as a criteria for defining obesity came out to be 39.7% and 47% respectively.

In the current study, among the various socio-demographic characteristics studied; age, gender, education, occupation, socio-economic and marital status were found to be statistically significant*(p <0.05).*

Prevalence of Obesity according to Waist Circumference:

The prevalence of obesity using waist circumference as a criteria among adults was 39.7% which was comparable to that observed by Abdeen et al[19] (2012) (37.8%). However, contrasting result was observed by Agrawal et al[20] (2006) (15.7%). On the other hand, Gupta etal[21] (2011) (47.5%), Rao et al[22] (2011) (51.7%), Bhardwaj et al[23] (2011) (68.9%) and Sawant et al[24] (2011) (70.9%) reported a higher prevalence.

The prevalence of obesity among males in the index study was 27.8%. Similar finding was observed by Gupta et al[21] (2011) (29.6%). However, it was higher as compared to that of Rao et al[22] (2011) (18%) and Abdeen et al[19] (2012) (20%). On the other hand, Bhardwaj et al[23] (2011) reported a higher prevalence (62.2%).

The prevalence of obesity among females in the present study was 52.7%. This finding was higher as compared to that of Jiaet al[25] (2002) (35.1%), Agrawal et al[20] (2006) (10.1%), Kaur et al[26] (2007) (2.7%), Krishnan et al[27] (2008) (13.2%) and Hingorjo et al[28](2009) (13%). On the other hand, Rao et al[22] (2011) (69.8%), Bhardwaj et al[23] (2011) (74.8%), Gupta et al[21](2011) (79.8%) and Abdeen et al[19] (2012) (55.7%) reported a higher prevalence.

Prevalence of Obesity according to Waist-Hip Ratio:

In the current study, using WHR as a tool, prevalence of obesity among adults was 47.0%. This finding was higher as compared to that of Abdeenet al[19] (2012) (27.8%). On the other hand, Gupta et al[21] (2011) (60.8%), Rao et al[22] (2011) (62.1%) and Sawant et al[24] (2011) (73.8%) reported a higher prevalence in their respective study.

The prevalence of obesity among males in our study was 33.7%. This finding was higher as compared to that of Rao et al[22] (2011) (13.4%) and Abdeen et al[19] (2012) (8.8%). On the other hand, Gupta et al[21] (2011) (43.8%) reported a higher prevalence.

The prevalence of obesity among females in the existing study was 61.5%. This result was higher as compared to that of Abdeenet al[19] (2012) (46.8%). On the other hand, Rao et a22 (2011) and Gupta et al[21] (2011) reported a higher prevalence of 88.3% and 91.5% respectively.

Prevalence of Obesity according to BMI:

The overall prevalence of obesity using BMI as a method was 13.4%.

This finding was further corroborated by Tiwari et al[29] (2009) (13.7%).However, it was higher as compared to that of Vaderaet al[30] (2010) (5.2%) and Rao et al[22] (2011) (6.6%). On the other hand, Shayoet al[31] (2011) (19.2%), Gupta et al[21] (2011) (19%), Sawant et al[24] (2011) (33.8%), Bhardwaj et al[23](2011) (50.1%) and Abdeen et al[19] (2012) (24.4%) reported a higher prevalence in their respective study.

The prevalence of obesity among males in the present study was 9.0%. This finding was comparable to that observed by Shayoet al[31] (2011) (9%). However, it was higher as compared to that of Rao et al[22] (2011) (6%). On the other hand, Bhardwaj et al[23] (2011) (50.2%) and Abdeen et al[14] (2012) (17.5%) reported a higher prevalence.

The prevalence of obesity among females in the present study was 18.0%. This finding was further corroborated by Anuradha et al[32] (2011) (19.8%). However, it was higher as compared to that of Rao et al[22] (2011) (6.9%). On the other hand, Bhardwaj et al[23] (2011) (50%) and Abdeen et al[19] (2012) (31.5%) reported a higher prevalence in their respective studies.

These large differences in prevalence rates may be due to differences in methodology, definitions, different assessment parameters and different cut-off points used for defining obesity by different researchers in different geographical regions.

Recently, various organizations have proposed indices of waist circumference to assess central obesity. The use of WC has gained popularity in recent years. It is increasingly being accepted as the best anthropometric indicator of abdominal adiposity and is one of the five anthropometric indices for diagnosing obesity. Furthermore, WC is a better index as compared to BMI and is used as a measure of obesity [33, 34].

BMI has traditionally been the chosen indicator for measuring body size as well as composition. It is also meant to diagnose overweight and underweight. But later, alternative measures that reflect abdominal adiposity, such as WC, WHR and WHtR (waist-height ratio) have been suggested to be superior to BMI in predicting metabolic abnormalities like CVD, diabetes, hypertension as abdominal obesity is based largely on the increased visceral adipose tissue is associated with a range of metabolic abnormalities [34].

Association of Socio-Demographic Characteristics with Obesity:

The current study revealed that on overall analysis, the prevalence of obesity has a rising trend with age. The prevalence of obesity was lowest (11.2%) in the age group of 18 to 25 years and then increased as the age advanced till 65 years, where the maximum prevalence noticed was 59.2 %, and this association in the trend between age and obesity was found to be statistically significant. However on sub-group analysis according to gender, no trend was observed with age, but the association between obesity and age was found to be highly significant. This finding of an association of age with obesity was consistent with the findings by Shayoet al[31] (2011) and Gupta et al[21] (2011).On the contrary, Subramaniamet al[35] (2011) and Anuradha et al[32]**(2011)** reported no significant association between age and obesity. This study revealed that females had higher prevalence (52.7%) of obesity as compared to males (27.5%) and this difference in prevalence between the two sexes was statistically significant. This finding was supported by Shayo et al[31] (2011), Gupta et al[21](2011) and Sawant et al[24] (2011) in their respective study.

In the present study, the prevalence of obesity was lowest (28.6%) in upper lower class, and this prevalence increased with higher SES, as it was highest (48.2%) in upper class, and also this trend between SES and obesity was found to be statistically significant on overall analysis. This difference may be due to paucity of food because of financial constraints in lower socioeconomic classes. This result was substantiated with the findings of Shayo et al[31] (2011)and Rao et al[22] (2011). On sub-group analysis according to gender, no trend was observed with SES and also the association between obesity and SES was not found to be statistically significant in either of the sex which is contrary to the findings of index studies by Anuradha et al[32] (2011).

It was observed in the existing study that the prevalence of obesity was lower among unmarried group as compared to married, divorced/separated or widow/widower group and significant association was found between marital status and obesity. These results were supported by Shayo et al[31] (2011) and Abdeen et al[19] (2012). On the other hand, distinct results were mentioned by Anuradha et al[32] (2011),where no significant relation of obesity with marital status was found.

The other socio-demographic attributes like religion, caste, type of family & family size were also studied, but were found to be non-significant statistically *(p >0.05)*.

Conclusion & Recommendations:

The findings of the present study suggest that WHR, WC, BMI are independent variables in predicting the health risk. And on the whole, obesity assessed by waist-hip ratio is a better predictor than BMI for interpreting the metabolic risk. Furthermore, the study explains that the waist-to-hip (WTH) ratio is a common measure of fat distribution and their usefulness of WC and WHR for prediction of disease risk.Based on the findings of this study, we found waist circumference as an easy and feasible screening tool that can be used for early detection of obesity among Indians.

WHR/WC can help a person to track his/her weight loss progress and also can be served as a warning of estimated health risk for troubles related to being overweight, such as heart disease, type two diabetes, arthritis, and cancers like colon, breast, esophageal, uterine, ovarian, kidney, lung and pancreatic cancer.In the light of the rising burden of NCDs and of government efforts to control NCDs in India, NCD risk factor surveillance should be a priority for the national health information system. As obesity is a precursor for number of NCDs like CHD, Diabetes & Stroke, and a national program has been developed for their prevention & control; what is required is its propaganda at all the levels of health care delivery system by various IEC activities for creating awareness about the hazards of obesity and its prevention among the masses.To start institutes, through which public awareness can be increased regarding obesity and its dreaded sequelae; and also measures (like yoga) to attain normal weight with healthy life-style can be imparted.

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