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SCREENING TOOLS FOR OBESITY;
EVALUATION OF WAIST HIP RATIO, WAIST CIRCUMFERENCE AND BMI AMONG HYPERTENSIVE PATIENTS IN A TERTIARY CARE HOSPITAL

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ABSTRACT… Background: Various anthropometric tools employed to assess obesity include body mass index (BMI) and waist to hip ratio (WHR) and waist circumference (WC) among others. An increased prevalence of central obesity in Asians calls for evaluation of WHR, WC and BMI as screening tools for obesity among them so as to give a clue about performance of these screening measures in detection of obesity. **Study Design:** Cross sectional analytical study. **Setting:** Allied Teaching Hospital Faisalabad. **Study Period:** December, 2014 to November, 2015. **Methods**: 377 patients of essential hypertension screened for obesity, using BMI, WHR and WC as screening tools and analyzed and compared their performance in detecting obesity among study subjects. Taking BMI as gold standard, the sensitivity and specificity of WHR and WC was measured along with their positive and negative predictive values. Study subjects were also categorized according to "BMI trigger points for public health consideration" risk categories suggested by WHO for Asian populations. **Results:** Among 377 study subjects, 239 (63.39%) were categorized as obese by WHR measurements and 254 (67.33%) individuals were labelled as obese by WC measurements compared to 209 by BMI (*p*-value 0.00 in both cases). This showed a trend towards abdominal pattern of obesity among study subjects. The difference was significant among male as well as female portions of study population, where out of 249 study subjects of male gender, 145 (58.23%) were categorized as obese according to WHR and 156 (62.65%) were labelled as obese according to WC, compared to 125 overweight or obese by BMI (*p*-value 0.00). Females showed a similar trend with 98 (76.56%) out of 128 labelled as obese by WC and 94 (73.43%) by WHR compared to 84 (65.62%) by BMI. The difference between WHR and BMI in detecting obesity among females was a less significant compared to males. Out of 377 total subjects, 335 fell into increased, high or very high risk categories according to "BMI trigger points for public health consideration". WC showed a sensitivity of 97.13% and specificity of 69.64% whereas WHR showed a sensitivity of 96.65% and specificity of 77.98% when compared as screening tools with BMI as gold standard. **Conclusions**: WC performed better as a screening tool for obesity when compared with WHR among hypertensive patients. Higher number of obese patients detected by both WC and WHR than BMI showed tendency towards central obesity among study subjects. This difference underscores the relevance of using WC or WHR as measures of obesity especially among Pakistani population.

Key words: (MeSH): Obesity, BMI, WHR, WC

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INTRODUCTION

This study was in response to research world over that showed people of Indian ethnicities more prone to the phenomenon of central obesity rather than generalized obesity. Waist hip ratio and waist circumference are considered better indicators of central obesity as data world over has shown. This study aimed to analyze WHR and WC as well as BMI on a select hypertensive study population. Findings of this study underscore the point of adapting WC and WHR as measures of choice for screening obesity among Pakistani population as not only did they perform better in detection of obesity among this study population but also they are easier to employ and cost effective.

Obesity is an ever increasing phenomenon worldwide with potentially fatal consequences. World Health Organization states that the prevalence of obesity to have doubled between 1980 and 2008.[1] The rise in prevalence of obesity world over can be attributed to improving socio economic conditions, availability of fat rich fast foods and changing eating habits. Trend among urban working classes has shifted onto consuming readily available fast food which are rich in fats and carbohydrates and have become one of the chief reasons behind increasing prevalence of obesity especially in developed and developing countries.[2] Increasing stress levels due to modern day lifestyles are another contributing factor towards obesity epidemic.[3] This problem has become even more apparent in developing countries. As more people become part of middle income strata with access to varieties of food, there is a rising tendency towards weight gain and obesity.[4] And being a modifiable and independent risk factor for cardiovascular diseases[5], this rising prevalence of obesity is both a public health as well as economic concern. Globalization has had its own role in promoting obesity especially in developing countries. With working hours becoming ever more inconvenient, the eating habits have shifted to high fat readily available food. This in turn has resulted in ever increasing obesity prevalence.[6]

Defined as accumulation of excess fat in the body, obesity itself is an independent risk factor for various cardiovascular diseases.[5] It is an established fact that obesity is a precursor to dyslipidemia, hypertension, myocardial infarction, coronary artery disease etc.[7] An increase in prevalence of obesity means that more of the population is putting themselves at risk for developing various cardiovascular diseases. In addition to being a vast public health problem, this has its economic draw backs and is detrimental to collective development of a society.[8] Just how big this problem is can be explained by the simple fact that WHO estimates 2.8 million deaths every year to be attributed to obesity and its complications mainly cardiovascular disease. Even though the prevalence of obesity, when measured by the standard technique of body mass index (BMI), is much higher in developed countries compared to developing countries[9], the prevalence of cardiovascular diseases is greater in developing and non-developed regions.[10] According to one estimate, least-developed and developing countries contribute 85% to world's cardiovascular disease burden, with hypertension and dyslipidemia occurring the earliest chronologically in this cascade of cardiovascular diseases.[11] This is apparently at odds with the fact that obesity is probably the most important precursor of cardiovascular diseases and proportion of people developing cardiovascular disease ought to have some relation with prevalence of obesity in same population. This paradox is explained by the difference of patterns of obesity among different populations. Tendency of some of the races and ethnic groups towards central obesity which may or may not be detectable by standard anthropometric tool of BMI, helps explain this apparently non-consistent fact.[12]

Central or abdominal obesity by definition is accumulation of excess fat in central visceral region of the body. Some individuals tend to have excess fat deposited into their sub cutaneous tissue while others have fat stored in central region around abdominal viscera thus giving rise to central obesity.[13] These different tendencies are apparent when Caucasian and Oriental populations are compared for their patterns of obesity. Caucasians show a trend towards generalized type of obesity where fat accumulates in subcutaneous regions of the body while Oriental and Asians tend to accumulate fat more in their central visceral region.[14] Central obesity has been shown to have much greater association with cardiovascular diseases than general variety of obesity. In other words people who have central type of obesity are at a greater risk of developing cardiovascular disease than people with a generalized variety of obesity.[15] This explains the higher prevalence of cardiovascular disease among Asians.[16] Central obesity is harder to detect by employing standard screening tool of body mass index

(BMI), especially at it recommended cut off values. The WHO recommended cut off values of BMI, while good for detecting obesity that is of generalized variety, are not that sensitive to detect central obesity, which may go un noticed.[17] There is also the fact that standard BMI cut off points of 25 kg/m^2 and 30 kg/m^2 as points for categorizing individuals as overweight and obese respectively, are most sensitive when employed on Caucasian population, while they lose their predictive value when employed upon Asian populations.[17] This matter is further complicated when we consider the fact that most of non-Caucasians (Orientals, South Asians etc.) tend to accumulate excess fat in their visceral regions and are more prone to having central obesity as opposed to generalized obesity.[16] It was this fact that prompted the WHO expert consultation to suggest "public health action trigger points" of BMI for Asian populations.[18] These BMI trigger points suggested for Asian populations propose various BMI values beyond which a person can be categorized as being at, increased risk high risk or very high risk, for developing complications of obesity in future.

Considering the fact that most of the non-Caucasian population of the world falls into developing or least-developed categories as well as making up the major part of the cardiovascular disease burden of the world, this problem of central obesity going unnoticed by standard BMI cut off values becomes even more relevant. The need to evaluate and compare BMI with various other anthropometric tools for screening of obesity becomes important as obesity becomes a bigger economic and public health burden for developing countries.

The most accurate and effective technique that can be used to assess visceral accumulation of fat or central obesity is MRI[19], an imaging technique that can give a clear picture of presence of fat in various regions of human body, but it is neither cost effective nor available widely even in the developed world. On the other hand various studies have found waist hip ratio (WHR) and waist circumference (WC) measurements to be very good indicators of central obesity, as WHR and WC are linked with proportion of intra-abdominal fat and used in clinical settings to assess abdominal fat distribution.[17] This begs the question whether WHR and WC combined or individually can be better predictors of obesity compared to standard BMI cut off values, especially among South Asian populations given their tendency towards central type of obesity and high prevalence of cardiovascular disease.

RATIONALE OF THE STUDY

There have been studies in the western world which have evaluated BMI, WHR and WC as markers of obesity among both native populations and expatriate South Asians, but there is a dearth of research in this regard in Pakistan even though Pakistanis have a greater tendency towards central obesity[17] and have a high prevalence of cardiovascular disease. This study aims to fill that gap and analyze the value of BMI, WHR and WC as screening tools for obesity among Pakistani adults with hypertension.

OBJECTIVES

1. To find out patterns of obesity among adult patients of essential hypertension.
2. To compare WHR and WC as screening tools for obesity with BMI as gold standard.
3. To categorize study population according to "BMI public health trigger points for Asians" suggested by WHO expert consultation.

HYPOTHESIS

Null hypothesis

There is no difference between WHR, WC and BMI when used for detection of obesity among hypertensive adults.

Alternate hypothesis

There is a difference between WC, WHR and BMI when used for detection of obesity among hypertensive patients.

METHODOLOGY

Study Setting

Study was conducted at Allied Teaching Hospital Faisalabad.

Study Duration and data collection
Study was conducted from December, 2014 to November, 2015. Data were collected within this time period.

Study Design
This was a cross-sectional analytical study.

Study Population
The study population comprised of 377 patients of essential hypertension who were aged 18 years or above and presented in medical OPD and emergency department of Allied Hospital Faisalabad.

Sample Size
The sample size was 377 calculated with Raosoft sample size calculator with 5% margin of error and 95% confidence level for a population size of 20000 and 50% response distribution.

Sampling Techniques
Non Probability Purposive Sampling Technique was used.

Sample Selection
Inclusion Criteria
- Adults of 18 years and above incident cases of essential hypertension presenting in OPD and emergency department of a tertiary care hospital.
- Male and female genders.

Exclusion Criteria
- Any comorbidities with essential hypertension
- Pregnancy

Variables of Primary Interest
- Age in years
- Gender (categorical)
- Blood pressure in mmHg
- Height in meters
- Weight in kilograms
- Waist circumference in centimeters
- Hip circumference in centimeters
- Waist to hip ratio
- Body mass index (Kg/m^2)

OPERATIONAL DEFINITIONS
Waist circumference greater than 90 cm for men and greater than 80 cm for women was taken as cut off point for central obesity as per WHO guidelines.[20]
Waist to hip ratio of greater than 0.90 for men and 0.80 for women was taken as central obesity as per WHO guidelines.[20]
BMI of 18.5 - 24.9 kg/m^2 was categorized as normal
BMI of 25 - 29.9 kg/m^2 was categorized as over weight
BMI of 30 kg/m^2 or greater was categorized as obese
As per WHO guidelines[18]
Trigger points for public health action were;
BMI 23 kg/m^2 or higher represent increased risk.
BMI 27.5 kg/m^2 or higher represent high risk.
BMI 32.5 kg/m^2 or higher represent very high risk.
As per WHO expert consultation guidelines for Asians[18]

Data Collection Procedure
Data was collected at outpatient department and emergency department of Allied teaching hospital Faisalabad during February 2015 to October 2015. Permission to carry out research was obtained from medical superintendent of the hospital and dean of the medical department. Adults of 18 years and above of both male and female genders were included in the study. All the patients who presented in OPD and emergency having raised blood pressure with symptoms such as headache, dizziness etc. were examined by the physician present in hospital. Patients diagnosed with essential hypertension were requested for their written consent to be included in the study. Medical specialist examined the patients for co-morbidities such as diabetes, endocrine disturbances, renal or liver failures, secondary hypertension and clinical heart disease and only patients without these co morbidities were include in the study. Pregnancy was ruled out by a female medical officer present on the premises. Consent was taken by the researcher on a written form.

Blood pressure
BP was measured by auscultatory method using a mercury sphygmomanometer with an adult cuff on the right arm and patient sitting in a chair with back support and both feet planted on the ground.

Waist circumference
The Measurement was made at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest at the end of a normal expiration with a stretch resistant measuring tape snug around the body, and not pulled with subject standing with arms at the sides, feet positioned close together, and weight evenly distributed across the feet as per WHO STEPS protocols.[20]

Hip circumference
Hip circumference measurement was taken around the widest portion of the buttocks with a stretch resistant tape and subject standing with both arms at sides, feet together and weight evenly distributed.

Height
Height was measured with subject standing bare footed on a level floor with no carpeting in light clothes and no headgear with back touching the wall.

Weight
Weight was measured with subject standing bare feet on the center of the scale placed on a flat floor and wearing light clothing.

All the demographic data were collected through one on one interview, and above mentioned data was recorded on a custom designed proforma.

Statistical Analysis
Statistical analyses were performed by using SPSS version 23.
Continuous variables such as age, weight, height, waist circumference, hip circumference etc. were expressed as mean and standard deviation (SD).

Categorical variables like gender, WHR, BMI were expressed as frequencies and percentages. Kolmogorov Smirnov test for equality of variances were applied to assess the normality of distribution of study population. Contingency tables were drawn and chi-square test applied. Both overweight and obese categories according to BMI measurements were considered as obese for contingency tables and p-values of less than 0.05 were considered as significant.

Sensitivity and specificity of waist circumference and waist hip ratio were calculated with BMI as gold standard.

Age
Age of the study subjects ranged from 22 years to 83 years with a mean of 49.88 and standard deviation (SD) of ±13.557. Age distribution of study population was not normal with a Kolmogorov-Smirnov Z value of 1.413 and *p*-value of 0.037, showing statistically significant abnormality in age distribution. Out of 377 total study subjects, 114 (30.2 %) were aged 40 years or below while 263 (69.8 %) individuals were of age 41 years or above. Among the female subgroup of 128, 46 (35.9 %) were aged 40 years or less while 68 (27.30 %) among 249 males were aged 40 years or less. Those falling in category of age 41 years or more were 181 (72.7 %) males and 82 (64.1 %) females (Table-4.I).

Gender
Out of 377 patients of essential hypertension who consented to this study 128 (34%) were females and 249 (66%) were males. Male to female ratio was 1.94.
Levene's test for statistical equality of variances in case of gender and BMI and gender and WHR gave values of 12.569 and 86.230 with *p*-values of 0.00 in both the cases showing the population variances to be unequal thus excluding the use of parametric tests.

Body mass index (BMI)
BMI values across the study population showed a mean of 20.1 kg/m^2 and standard deviation of ±2.40 with a minimum of 20.1 kg/m^2 and maximum of 33.8 kg/m^2.

Out of 377 study subjects 168 (44.6%) fell within BMI of 18.5 to 24.9 kg/m^2 which is categorized as normal while 190 (50.4%) subjects were in BMI range of 25 to 29.9 kg/m^2 and categorized as overweight and 19 (5%) fell in BMI category of 30 kg/m^2 or above and were termed as obese (Figure 1).

Higher number of females (84 out of 128) fell into overweight and obese categories compared to males(*p*-value of 0.004) in which 125 out of 249 fell in overweight or obese categories with a (Table 4.III) (Figure 2).

A Kolmogorov Smirnov Z value of 1.567 and *p*-value of 0.014 showed that BMI distribution among study population was not normal. Non parametric test chi-square was applied.

Body mass index of 65 (57 %) out of 114 individuals of age less than 41 years was in the category of overweight while 9 (8 %) were classifies as obese among these 114 subjects. Among individuals who were 41 years or older in the study sample 125 (47.5 %) were in overweight category while 10 (3.8 %) were in obese category. Difference of obesity by BMI between two age groups was significant at *p*-value of 0.026 with younger hypertensive individuals in this study showing a greater tendency towards obesity (Table-4.II).

Waist hip ratio (WHR)

Waist hip ratios of greater than 0.90 for males and greater than 0.80 for females was taken as cut off points for categorizing individuals as obese or non-obese/normal as recommended by WHO STEPS protocols for Asians. Minimum WHR among study sample was 0.72 and maximum was 1.30 with a mean of 0.91 and standard deviation of ±0.078.

Out of 377 study subjects, 138 (36.6%) fell into normal category according to this criteria while 239 individuals fell into obese category (Figure 3).

Among 138 normal individuals according to WHR, 104 were males while 34 were females. While 239 (63.4%) were categorized as obese with significantly higher number of females once again falling into obese category i.e. 94 out of 128 female study subjects were categorized as obese while 34 were in normal category (Table 4.IV) and this difference was found to be statistically significant when non-parametric test of chi-square was applied (*p*-value 0.004) (Figure 4). BMI had found 84 out of 128 females falling into obese or overweight categories.

WHR distribution across study population showed an abnormal trend with a Kolmogorov Smirnov Z value of 1.575 and a *p*-value of 0.014.

Among 114 individuals in study population who were of the age 40 years or younger, 83 (72.8 %) were categorized as obese by waist hip ratio measure of obesity. On the other hand 156 (59.3 %) out of 263 study subjects of 41 years of age or older were categorized as obese. Chi-square test was applied and the difference between two age groups was statistically significant with higher number of younger sub group in study sample showing a trend towards obesity (*p*-value 0.014) (Table-4.IV).

Waist circumference (WC)

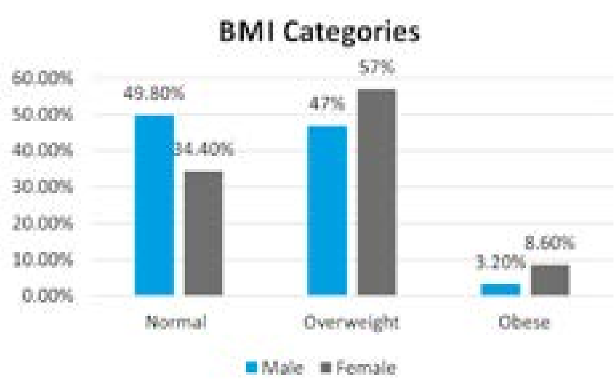
A total of 377 individuals participated in this study with 249 males and 128 females. Waist circumference of greater than 90 centimeters for males and greater than 80 centimeters for females were taken as cut off points for categorizing study subjects into normal and obese categories. Waist circumference among study population ranged from a minimum of 73 cm to 13 a maximum of 108 com. A total of 123 (32.6 %) participants among study sample of 377 were labelled as normal and 254 (67.4 %) were categorized as obese according to waist circumference measure of obesity (Figure 5).

Among 128 females in this study group 98 (76.6 %) were classified as obese and 30 (23.4 %) were labelled as normal (Table 4.VI). In the male subgroup of 249 individuals, 156 (62.7 %) were labelled as obese while 93 (37.3 %) fell into normal category (Figure 6). Significantly higher number of females were categorized as obese by waist circumference measure of obesity compared to males (p-value 0.008 by chi-square) (Table 4.VI).

Out of 114 study participants who were aged 40 years or younger 88 (77.2 %) were categorized as obese and 26 (22.8 %) were labelled as normal. Among the age group of 41 years or older 166 (63.1 %) were in the obese category and 97 (36.9 %) were labelled as normal by waist circumference measure of obesity. Non parametric tool of chi-square placed this difference as significant with a p-value of 0.008 (Table 4.VII).

BMI trigger points for public health consideration

When evaluated for WHO recommended trigger points for public health action, 42 (11.14 %) individuals were in no risk category that is BMI of less than 23 kg/m2. 255 (67.63%) were in increased risk group that is BMI of 23 kg/m^2 to 27.4kg/m^2. Another 78 (20.69%) fell into high risk category with BMI of 27.5 kg/m^2 to 32.4 kg/m^2. Only 2 (0.53%) of individuals were in high risk group of BMI 32.5 kg/m^2 or higher (Table 4.VIII) (Figure 7).



WHR vs BMI

WHR was able to pick more of the study subjects as obese with 239 (63.39%) individuals categorized as obese compared to 209 (55.43%) overweight or obese by standard BMI cutoff points.

Non parametric test chi-square was applied which labelled this difference to be statistically significant (p-value 0.00) for whole of the sample as well as for males and females individually (p-value 0.00 for both males as well as females).

Both overweight and obese individuals categorized by BMI were considered as obese for application of non-parametric tests.

WHR as screening test for obesity.

By taking BMI as gold standard for obesity screening, the sensitivity, specificity and positive and negative predictive values of WHR for this sample were calculated.

Sensitivity was 96.65% while specificity was 77.98%. Waist hip ratio showed a positive predictive value of 84.52% and a negative predictive value of 94.93%.

Waist circumference vs BMI.

Waist circumference was able to pick more of the study subjects as obese with 254 (67.37%) individuals categorized as obese compared to 209 (55.43%) overweight or obese by standard BMI cutoff points.

Non parametric test chi-square was applied which stated this difference to be statistically significant (p-value 0.00) for whole of the sample as well as for males and females individually (p-value 0.00 for both males as well as females).

Both overweight and obese individuals categorized by BMI were considered as obese for application of non-parametric tests of significance.

Waist circumference as screening test for obesity.

Using BMI as gold standard for obesity screening, sensitivity, specificity, positive predictive value and negative predictive value for waist circumference was calculated from a 2×2 table. Both over weight and obese categories according to BMI were considered as obese for this purpose. Sensitivity of waist circumference was found to be 97.13% while specificity was 69.64%. A positive predictive value of 79.92% and negative predictive value of 95.12% was obtained through 2×2 table.

Age	Male	Female	Total
≤ 40 years	68 (27.3%)	46 (35.9%)	114 (30.2%)
≥ 41 years	181 (72.7%)	82 (64.1%)	263 (69.8%)
Total	249 (100%)	128 (100%)	377 (100%)

Table 4.I. Age specific classification of study population showing 263 (69.8 %) of study subjects aged 41 years or above.

	BMI Categories			
Age	Normal	Overweight	Obese	Total
≤ 40 years	40 (35%)	65 (57%)	9 (8%)	114 (100%)
≥ 41 years	128 (48.7%)	125 (47.5%)	10 (3.8%)	263 (100%)

Table 4.II. Age specific classification of study population into BMI categories with individuals of age equal to or lesser than 40 years showing a greater trend towards overweight and obesity (p-value 0.026).

BMI Categories	Male	Female	Total
Normal	124 (49.8%)	44 (34.4%)	168 (44.56%)
Overweight	117 (47.0%)	73 (57.0%)	190 (50.4%)
Obese	08 (3.2%)	11 (8.6%)	19 (5.04%)
Total	249 (100%)	128 (100%)	377 (100%)

Table 4.III: Gender based BMI categorization of study population with higher number of females falling into overweight and obese categories compared to males (*p*-value 0.004).

BMI of 18.5 - 24.9 kg/m^2 was categorized as normal

BMI of 25 - 29.9 kg/m^2 was categorized as over weight

BMI of 30 kg/m^2 or greater was categorized as obese

	WHR Categories		
Age	Normal	Obese	Total
≤ 40 years	31 (27.2%)	83 (72.8%)	114 (100%)
≥ 41 years	170 (40.7%)	156 (59.3%)	263 (100%)

Table 4.IV. Age specific categorization of study population into normal and obese categories based on waist hip ratio with younger sub group showing a greater trend towards obesity (*p*-value 0.014).

WHR of > 0.90 for males and >0.80 for females was categorized as obese

WHR Categories	Male	Female	Total
Normal	104 (41.67%)	34 (26.56%)	138 (36.60%)
Obese	145 (58.23%)	94 (73.44%)	239 (63.4%)
Total	249 (100%)	128 (100%)	377 (100%)

Table 4.V. Gender specific WHR categorization of study population into normal and obese categories with females showing a greater trend of obesity compared to males (*p*-value 0.004)

WHR of > 0.90 for males and >0.80 for females was categorized as obese

WC Categories	Male	Female	Total
Normal	93 (37.3%)	30 (23.4%)	123 (32.6%)
Obese	156 (62.7%)	98 (76.6%)	254 (67.4%)
Total	249 (100%)	128 (100%)	377 (100%)

Table 4.VI. Gender specific categorization of study population into obese and normal categories based on WC cut off points.

WC of > 90 cm and > 80 cm was taken as cut off points for males and females respectively.

	WC Categories		
Age	**Normal**	**Obese**	**Total**
≤ 40 years	26 (22.8%)	88 (77.2%)	114 (100%)
≥ 41 years	97 (36.9%)	166 (63.1%)	263 (100%)

Table 4.VII. Age specific categorization of study population into normal and obese categories according to waist circumference.
WC of > 90 cm and > 80 cm was taken as cut off points for males and females respectively.

Category	Frequency	Proportion
No risk	42	11.14 %
Increased risk	255	67.64 %
High risk	78	20.69 %
Very high risk	02	0.53 %
Total	377	100 %

Table 4.VIII. Categorization of study population according to WHO's trigger points of BMI for public health action.
BMI 23 kg/m^2 or higher represent increased risk.
BMI 27.5 kg/m^2 or higher represent high risk.
BMI 32.5 kg/m^2 or higher represent very high risk

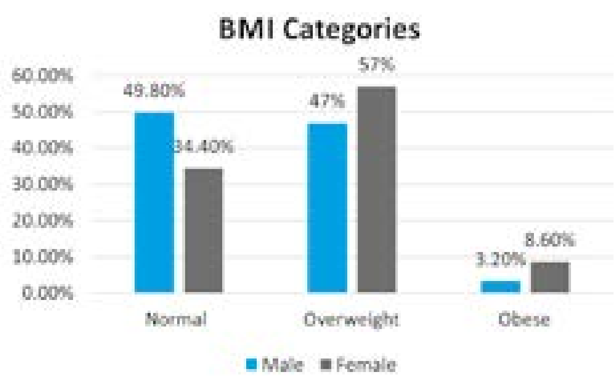


Figure 1: Gender specific BMI categories showing 57% and 8.6 % of females in the study sample falling into overweight and obese categories respectively compared to 47 % overweight and 3.2 % obese males.

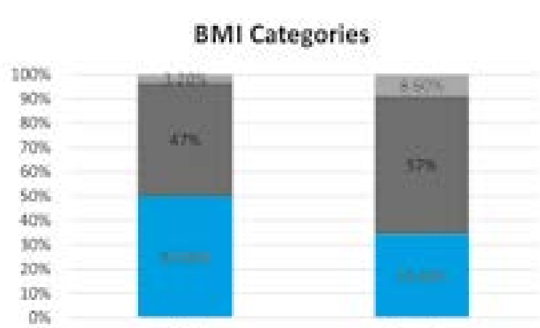


Figure 2: Gender specific BMI categories showing that higher percentage of female sub group of study sample were categorized as overweight and obese compared to males.

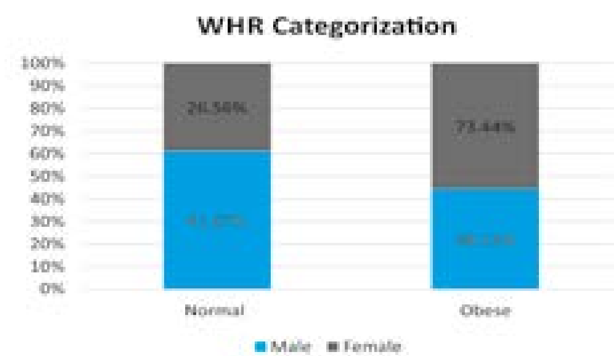


Figure-III. Gender specific WHR categories showing proportions of males and females among study population falling into normal and obese categories.

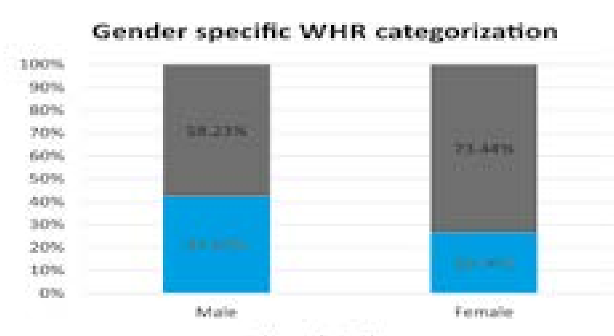


Figure-4. Gender specific WHR categories showing proportions of males and females among study population falling into normal and obese categories.

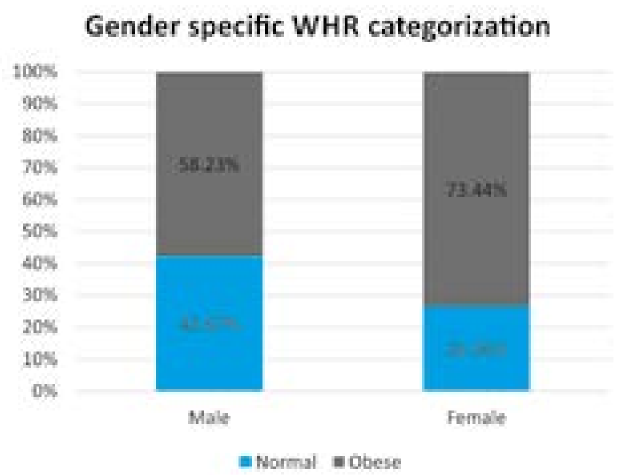


Figure-5. Categorization of study population into normal and obese according to WC measure showing contribution of male and female genders to both categories.

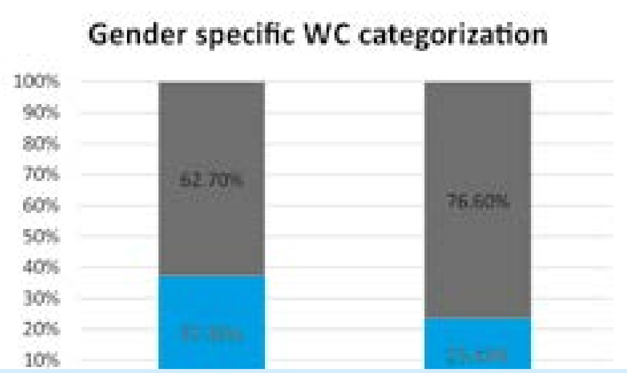


Figure-6. Proportion of normal and obese among male and female sub groups of study population according to WC cut off points.

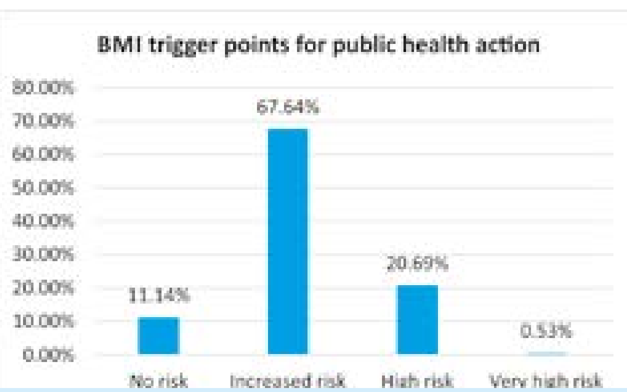


Figure-7. Categorization of study population according to BMI trigger points for public health action

DISCUSSION

This study aims to analyze waist hip ratio (WHR), waist circumference (WC) and body mass index (BMI) as screening tools for obesity. Hypertension being associated with obesity[21] was taken as inclusion criteria. Of the 377 individuals, all incident cases of hypertension evaluated in this study, 168 (44%) were categorized as normal weight according to standard BMI cut off points of 25 kg/m2 or higher while 209 (56%) individuals were categorized as overweight or obese. More of the female study subjects fell into overweight and obese categories (84 out of 128) compared to male participants of this study (125 out of 249). This difference was statistically significant with *p*-value of 0.004. This difference among males and females may suggest that females were more inclined towards generalized type of obesity compared to the male participants as BMI is considered a measure more suited for detection of generalized variety of obesity.[22]

Number of people aged 40 years or less in this study population categorized as overweight or obese (74 out of 114) was greater in proportion to people aged 41 years or above (135 out of 263). This shows that hypertensive study participants who were younger than 41 years of age were more often found to be obese than people of age 41 years and older in this study sample.

Waist to hip ratio (WHR) was able to categorize 239 (64%) people into obese category and 145 of these 239 were males and 94 females. More of the females (94 out of 128) fell into obese and overweight groups compared to males (145 out of 249) by WHR method and this difference was again statistically significant (*p*-value 0.004).

Among 114 study participants younger than 42 years of age, 83 (72.8%) were found to be obese by WHR compared to 156 out of 263 individuals aged 41 years or older. This again shows that among this study population more of the individuals younger than 41 years of age were found to be obese.

The overall difference among the whole study population, between WHR and BMI in detecting obesity, was however in favor of WHR as it was able to detect and categorize more of the obese individuals among this hypertensive study sample and the difference was statistically significant with *p*-value of 0.001. Ability of WHR measure to categorize more of the individuals in this study sample as obese compared to BMI seems to suggest that study population had more of a central or abdominal variety of obesity as opposed to generalized obesity as WHR is a measure more suited for detection of central type of obesity.[23,24] This underscores the point that waist hip ratio is an anthropometric tool for obesity detection is able to categorize more individuals in obese category among South Asian adults as previous studies have shown South Asians to be more prone to central obesity and WHR is considered a better measure of central obesity than BMI.[25] Results of this study were thus consistent with previous studies conducted among expatriate as well as native South Asian populations showing waist hip ratio to be a better measure compared to BMI.[25] Ability of WHR, a measure suited more for central obesity, to detect more individuals as obese in this study group also validates the results of studies conducted in other parts of the world that found expatriate South Asians to have central type of obesity as opposed to generalized obesity.[12]

Findings of this study were also consistent with studies conducted earlier for evaluation of WHR and BMI as anthropometric detection tools for obesity which had found WHR to be a better measure of obesity when compared to BMI at its standard cut off values. Previous studies conducted in Europe and Americas among native as well as expatriate populations of different ethnicities had found waist hip ratio (WHR) and waist circumference (WC) along with waist to height ratio to be better measures for obesity detection.[17]

Anthropometric tool of waist circumference (WC) was able to categorize 254 (67.4%) out of 377 study subjects as obese. This compared to 209 (55%) of study participants categorized as overweight or obese by standard BMI cut off points was statistically significant with a p-value of 0.00. Once again more of the females (98 out of 128) were labelled obese by WC measure than males in study group (156 out of 249). Ability of WC to categorize more of the individuals in this study population as obese suggests that study participants showed a trend towards central type of obesity as WC is a measure better suited for detection of central obesity.

These results were consistent with the findings of previous studies conducted elsewhere among people of Asian origin.[23]

Among 114 individuals who were aged 40 years or less in this study population, 88 were found to be obese by waist circumference (WC) measure of obesity as compared to 166 out of 263 individuals aged 41 or more. This once again shows that people aged 40 or less in this study sample were found to be obese more often than individuals of age 41 years or more.

Evaluation of WHR and WC as a screening tools for obesity with BMI as gold standard showed WHR to have a sensitivity of 96.65% and specificity of 77.98%. Waist circumference (WC) had a sensitivity of 97.13% and a specificity of 69.64%. These results were consistent with the studies conducted earlier. Comparable high sensitivities of both WHR and WC in this study sample shows that both can be applied as screening tests with little difference in obesity detection among this study population.

Evaluation of WHO “BMI trigger points for public health action” was able to produce results that categorized 335 (88.85%) of the study individuals into increased and high risk groups with 42 individuals falling into no risk categories. These trigger points for public health action were suggested in response to the fact that Asians showed a greater risk for cardiovascular diseases at BMI values lower than their Caucasian counterparts.[26] Labelling of 335 (88.85%) hypertensive adults in this study group signifies the need for application of these trigger points for public health action in Asian countries. The importance of adopting these “BMI trigger points for public health action”, instead of standard BMI cut off values, cannot be overstated. A much better capability to detect obesity in hypertensive patients was observed through revised BMI cut off points or BMI trigger points for public health action. Significant superiority of waist hip ratio and waist circumference over BMI for detection of obesity in this study group persisted for both male and female groups both individually as well as collectively thus confirming the alternate hypothesis in this study that there is a difference between WHR, WC and BMI when used for detection of obesity among this hypertensive study population and WC and WHR were able to detect more of the individuals as obese in this study.

Ability of WHR and WC to detect more of the individuals among this study population suggests that individuals tended to lean towards central obesity rather than generalized obesity.

CONCLUSIONS

This study aimed to assess waist hip ratio, waist circumference and body mass index as screening tools for obesity. Results showed waist hip ratio and waist circumference as better placed to predict obesity in study individuals than body mass index. The difference between the WHR and BMI in detecting obesity in this study population was significant at p-value 0.00. The difference between WC and BMI in detecting obesity among this study sample was significant with a p-value of 0.00. This differences however were more marked in case of male proportion of this study group than females who showed similar results by all measures used i.e. BMI, WHR and WC.

More of the Study subjects who were aged 40 years or less were found obese compared to individuals aged 41 years or older by all three anthropometric measures for obesity.

Evaluation of WC and WHR as screening tools for obesity with BMI as gold standard showed comparable sensitivities for both with WHR being more specific.

"Trigger points for public health action" were able to categorize a large number of study individuals as being at increased risk, high risk or at very high risk. This signifies the value of these recommended BMI trigger points in predicting potential for obesity in individuals who later on develop hypertension and other cardiovascular diseases.

In this study population, WHR and WC were better placed to detect obesity compared to BMI. Better performance of WHR and WC than BMI in predicting obesity among this study sample signifies the fact that study population had a tendency towards central obesity rather than generalized obesity. Results of the study also validate the point that South Asians show a greater trend towards central obesity rather than generalized obesity.

REFERENCES

1. Nguyen DM, El-Serag HB. **The Epidemiology of Obesity.** Gastroenterology Clinics of North America. 2010;39(1):1-7.

2. Kain J, Vio F, Albala C. **Obesity trends and determinant factors in Latin America.** Cadernos de Saúde Pública. 2003;19:S77-S86.

3. Kivimäki M, Head J, Ferrie J, Shipley M, Brunner E, Vahtera J, et al. **Work stress, weight gain and weight loss: evidence for bidirectional effects of job strain on body mass index in the Whitehall II study.** International journal of obesity. 2006;30(6):982-7.

4. Wang Y. **Cross-national comparison of childhood obesity: the epidemic and the relationship between obesity and socioeconomic status.** International journal of epidemiology. 2001;30(5):1129-36.

5. Hubert HB, Feinleib M, McNamara PM, Castelli WP. **Obesity as an independent risk factor for cardiovascular disease: a 26-year follow-up of participants in the Framingham Heart Study.** Circulation. 1983;67(5):968-77.

6. Jebb SA, Moore MS. **Contribution of a sedentary lifestyle and inactivity to the etiology of overweight and obesity: current evidence and research issues.** Med Sci Sports Exerc. 1999;31(11 Suppl):S534-41.

7. Van Gaal LF, Mertens IL, De Block CE. **Mechanisms linking obesity with cardiovascular disease.** Nature. 2006;444(7121):875-80.

8. Yach D, Stuckler D, Brownell KD. **Epidemiologic and economic consequences of the global epidemics of obesity and diabetes.** Nature medicine. 2006;12(1):62-6.

9. Prentice AM. The emerging epidemic of obesity in developing countries. International Journal of epidemiology. 2006;35(1):93-9.

10. Reddy KS, Yusuf S. **Emerging epidemic of cardiovascular disease in developing countries. Circulation**. 1998;97(6):596-601.

11. Nishtar S. **The National Action Plan for the Prevention and Control of Non-communicable Diseases and Health Promotion in Pakistan--Prelude and finale.** JPMA. The Journal of the Pakistan Medical Association. 2004;54(12 Suppl 3):S1-8.

12. Sniderman AD, Bhopal R, Prabhakaran D, Sarrafzadegan N, Tchernof A. **Why might South Asians be so susceptible to central obesity and its atherogenic consequences? The adipose tissue overflow hypothesis.** International journal of epidemiology. 2007;36(1):220-5.

13. Gesta S, Blüher M, Yamamoto Y, Norris AW, Berndt J, Kralisch S, et al. **Evidence for a role of developmental genes in the origin of obesity and body fat distribution.** Proceedings of the National Academy of Sciences. 2006;103(17):6676-81.

14. Kumar B, Meyer H, Wandel M, Dalen I, Holmboe-Ottesen G. **Ethnic differences in obesity among immigrants from developing countries, in Oslo, Norway.** International journal of obesity. 2006;30(4):684-90.

15. Larsson B, Svärdsudd K, Welin L, Wilhelmsen L, Björntorp P, Tibblin G. **Abdominal adipose tissue distribution, obesity, and risk of cardiovascular disease and death: 13 year follow up of participants in the study of men born in 1913.** Br Med J (Clin Res Ed). 1984;288(6428):1401-4.

16. McKeigue P, Shah B, Marmot M. **Relation of central obesity and insulin resistance with high diabetes prevalence and cardiovascular risk in South Asians.** The Lancet. 1991;337(8738):382-6.

17. Lee CMY, Huxley RR, Wildman RP, Woodward M. **Indices of abdominal obesity are better discriminators of cardiovascular risk factors than BMI: a meta-analysis.** Journal of clinical epidemiology. 2008;61(7):646-53.

18. WHO EC. **Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies.** Lancet. 2004;363(9403):157.

19. Iacobellis G, Assael F, Ribaudo MC, Zappaterreno A, Alessi G, Mario U, et al. **Epicardial fat from echocardiography: a new method for visceral adipose tissue prediction.** Obesity research. 2003;11(2):304-10.

20. Consultation WE. **Waist circumference and waist-hip ratio.** 2011.

21. Dorresteijn J, Visseren F, Spiering W. **Mechanisms linking obesity to hypertension.** Obesity Reviews. 2012;13(1):17-26.

22. Lapidus L, Bengtsson C, Hällström T, Björntorp P. **Obesity, adipose tissue distribution and health in women—results from a population study in Gothenburg, Sweden.** Appetite. 1989;13(1):25-35.

23. Zhang C, Rexrode KM, van Dam RM, Li TY, Hu FB. **Abdominal obesity and the risk of all-cause, cardiovascular, and cancer mortality sixteen years of follow-up in US women.** Circulation. 2008;117(13):1658-67.

24. Pouliot M-C, Després J-P, Lemieux S, Moorjani S, Bouchard C, Tremblay A, et al. **Waist circumference and abdominal sagittal diameter: best simple anthropometric indexes of abdominal visceral adipose tissue accumulation and related cardiovascular risk in men and women.** The American journal of cardiology. 1994;73(7):460-8.

25. Misra A, Chowbey P, Makkar B, Vikram N, Wasir J, Chadha D, et al. **Consensus statement for diagnosis of obesity, abdominal obesity and the metabolic syndrome for Asian Indians and recommendations for physical activity, medical and surgical management.** JAPI. 2009;57(2):163-70.

26. Gupta M, Singh N, Verma S. **South Asians and cardiovascular risk what clinicians should know.** Circulation. 2006;113(25):e924-e9.

"Be a voice,
Not an echo."

Unknown

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