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Original Research Article

Sensitivity and specificity of waist circumference as a single screening tool for assessment of overweight and obesity

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ABSTRACT

Background: Generalised and central obesity are established risk factors for metabolic syndrome and cardiovascular diseases. Easy assessment of overweight or obesity is the need of the hour from public health perspective. Waist circumference (WC) can be a simple screening tool for identifying overweight individuals since measuring WC is simple, inexpensive, less time consuming, convenient for self-monitoring and needs no complicated calculation as BMI.
Methods: A community based cross-sectional study was conducted in January-February 2017 among 338 adults, in a village of Singur Block, West Bengal. Height, weight and WC were measured for each subject. Receiver Operating Characteristic (ROC) curve analysis was used to estimate the cut-off values of WC.
Results: The sensitivity and specificity of WC ≥90 centimeters for men for identifying overweight (BMI ≥25) were 78.8% and 75.6% respectively, whereas those of WC ≥80 cm for women were 80.3% and 44% respectively. ROC curve analysis revealed good diagnostic accuracy at 88.5 cm for WC cut-off for men (area under curve (AUC) 0.854, sensitivity 86.5%, specificity 67.6%) and fair accuracy (AUC 0.744, sensitivity 80.3%, specificity 44%) for WC cut-off for 80 cm for women.
Conclusions: This study shows, WC can be used for screening of overweight individual infield practice as measuring tape is inexpensive and easy-to-carry compared to a weighing scale. More research may be done on larger sample size to establish an optimal WC cut-off value for Indian population.

Keywords: Obesity, Waist circumference, Body mass index, Sensitivity, Specificity

INTRODUCTION

Overweight and obesity are major public health problems of the current world.[1,2] In 2014, in the world, 39% of adults aged 18 years and above were overweight and 13% were obese.[3] Obesity is also an emerging health problem in countries like India. The rising prevalence overweight and obesity in India is directly correlated with the rising prevalence of obesity-related co-morbidities; hyper-tension, the metabolic syndrome, dyslipidemia, type 2 diabetes mellitus, and cardiovascular disease.[4,5]

Obesity is preventable. The cost of management of obesity and associated comorbidities are rising day by day.[6] So, more emphasis is required on prevention, mostly in young individuals who does not come in contact with health facility often. Therefore, easy assessment of overweight or obesity is the need of the hour from public health perspective.

Asian Indians have a unique tendency to accumulate excess body fat around the abdomen. They have higher percentage body fat, increased subcutaneous and intra-abdominal fat at lower or similar BMI levels as compared to white caucasians.[7-9] Measuring body adiposity by magnetic resonance imaging and computed tomography is highly reliable and valid but are costly, time consuming, requiring special skill and not feasible in

large community based studies.[10] Hence, waist circumference (WC) and body mass index (BMI) are commonly being used as surrogate measures for abdominal obesity and generalised obesity respectively.[10,11]

WC and BMI are closely correlated in measuring excess body fat deposition.[12] Measuring WC takes less time than measuring height and weight. The procedure can be learnt easily and a measuring tape costs minimal (compared to weighing scale and stadiometer required for BMI measurements). Besides, WC can be self-monitored and it doesn't need any calculation, unlike BMI.[12,13] Therefore, WC measurement can be used care by field workers as preferred single screening tool for detection of overweight or obese subjects for weight management in primary health.

According to WHO, BMI 25-29.99 kg/m^2 and BMI≥30 kg/m^2 has been classified as overweight and obese respectively.[14] Keeping in mind the clustering of cardiovascular risk factors and type 2 diabetes mellitus at lower levels of obesity among Asian Indian population than in non-Asian Indian populations, several medical experts suggested that, the diagnosis of obesity should be made at a lower level of weight for height among Asian Indians.[15] They came to consensus that, the classification should be normal BMI: 18.0-22.9 kg/m^2, overweight: 23.0-24.9 kg/m^2, obesity: >25 kg/m^2.[15] The use of optimal WC cut-off points for screening should be population specific, as suggested by most of the researchers.[16] The currently recommended optimal cut off for WC in India is 90 cm for men and 80 cm for women.[15]

With this background a community based study was conducted in rural area of West Bengal, to assess the sensitivity and specificity of the currently recommended WC cut-off values for identification of overweight and obesity based on BMI as the reference standard and further to determine optimal WC cut-off points for the rural population.

METHODS

A community based study of cross-sectional design was conducted in the month of September-October, 2016 in the service area of Rural Health Unit and Training Centre (RHUTC), Singur which is the rural field practice area under All India Institute of Hygiene & Public Heath (AIIH&PH), Kolkata. Ethical permission was taken from the institutional ethics committee. During this period, the researcher was posted twice weekly in the Diara Sub-centre and after the OPD hours, in the evening two hours per day was dedicated for data collection. During the study period, it was possible to collect data from 338 subjects.

The inclusion criteria were age above 18 years and those who have given informed written consent to participate in the study. Subjects were excluded if they had increased abdominal girth for causes other than abdominal adiposity (e.g. pregnancy, ascites, and other debilitating illness), physical disability, or mental illness. Those who could not stand upright were excluded from the study.

Non stretchable measuring tape, analog weighing scale and stadiometer were the study tools. The data were collected by interview and anthropometric measurements. Height, weight and waist circumference of each participant was measured. WC was measured at the midpoint between the inferior margin of the last rib and iliac crest using a non-stretchable measuring tape to the nearest 0.1 centimetre. The body weight was measured in light indoor clothing without shoes to the nearest 0.1 kilogram with the help of portable analog weighing machine. Height was measured without shoes to the nearest of 0.5 centimetre using a stadiometer, with the participant standing upright on a firm/level surface with heels apposed. All measurements were taken twice and the average was used for data analysis. Subjects were classified as overweight if BMI (computed as weight in kilograms divided by the square of the height in meters) was ≥25, based on the classification recommended by the World Health Organization.[16]

The data was analysed using SPSS software version 16.0. Sensitivity and specificity of the presently recommended WC cut off were calculated as true positive/ (true positive+false negative) and true negative/ (true negative+false positive) respectively. Receiver operating Characteristic (ROC) curve analysis was used to determine the optimal cut-off values of WC for identification of overweight or obesity.

RESULTS

Mean (SD) age of the participants were 34.2 (12.6) ranging from 18 to 72 years. Among the study participants 37.3% were men and 62.7% were women.

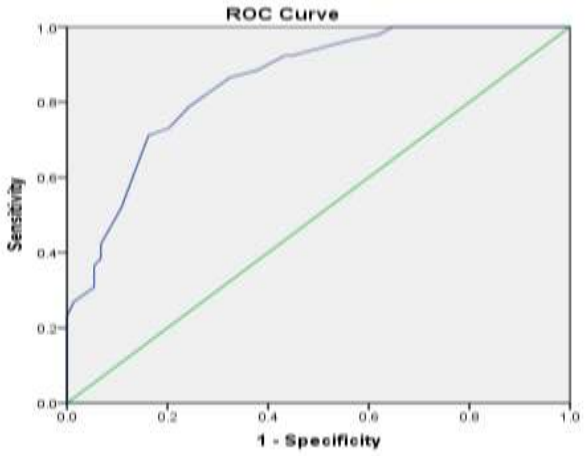

Figure 1: ROC analysis of waist circumference cut-off for identification of obesity (BMI≥25) among men [n=126].

We found, presently recommended WC cut-off value of 90 cm for men had 78.8% sensitivity and 75.6% specificity to diagnose overweight individuals and WC cut-off value of 80 cm for women had 80.3% sensitivity and 44% specificity for the same (Table 1).

Among men, WC cut-off value 88.5 cm has a better diagnostic accuracy to identify overweight with sensitivity 86.5%, specificity 67.6% and Area under curve (AUC) (0.854; 95% CI 0.79–0.92) (Figure 1).

Among women, WC cut-off value 80 cm, which is the currently recommended value, has a fair accuracy with sensitivity 80.3%, specificity 44% and Area under curve (AUC) (0.744; 95% CI 0.67–0.81) (Figure 2).

Table 1: Sensitivity and specificity of currently recommended waist circumference cut-off for identification of overweight and obesity among men and women.

Waist circumference (cms)		Classification according to BMI	
		BMI ≥25 n (%)	**BMI <25 n (%)**
Men (n=126)	≥90	41 (78.8)*	18 (24.3)
	<90	11 (21.2)	56 (75.7)#
Women (n=212)	≥80	90 (80.4)*	56 (56.0)
	<80	22 (19.6)	44 (44.0)#
		BMI ≥23 n (%)	**BMI <23 n (%)**
Men (n=126)	≥90	55 (67.9)*	4 (8.9)
	<90	26 (32.1)	41 (91.1)#
Women (n=212)	≥80	116 (80.6)*	30 (44.1)
	<80	28 (19.4)	38 (55.9)#

* Sensitivity, # Specificity.

Table 2: Predictive value and likelihood ratio of current waist circumference cut offs for identification of overweight (BMI≥23) and obesity (BMI≥25) among men and women.

Waist circumference		Classification according to BMI	
		BMI ≥25	**BMI ≥23**
Men (≥90 cm)	PPV	69.5%	93.2%
	NPV	83.6%	61.2%
	LR+	3.24	6.85
	LR-	0.28	0.36
Women (≥80 cm)	PPV	61.6%	79.5%
	NPV	66.7%	57.6%
	LR+	1.46	1.83
	LR-	0.45	0.35

PPV= Positive predictive value, NPV= Negative predictive value, LR+= Positive likelihood ratio, LR- = Negative likelihood ratio.

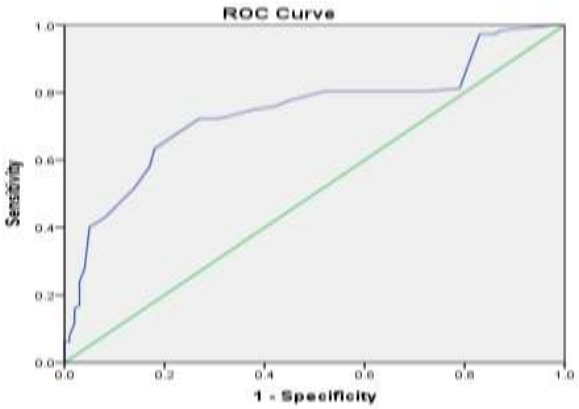

Figure 2: ROC analysis of waist circumference cut-off for identification of obesity (BMI≥25) among women [n=212].

DISCUSSION

In several studies all round the world researchers have preached for making WC a single screening tool for identifying overweight or obesity. A study conducted in North Glasgow came to a conclusion that, measurement of waist circumference for both men and women could be adopted as a simpler valid alternative to BMI for health promotion, by alerting those at risk of cardiovascular disease, and as a guide to risk avoidance by self-weight management.[17] Kee et al in a study conducted in Malaysia recommended WC with appropriate population specific cut-off as a single screening tool for identifying overweight and obesity and its use by health personnel involved in weight control programmes and health promotion activities.[18]

In our study we found that, the sensitivity of currently recommended WC cut off is 78.8% and 80.4% for identifying overweight (BMI≥25 kg/m^2, according to WHO classification) among men and women respectively, which is fair for a tool to be considered as a good screening tool. But in several studies in India, researcher have suggested a more stringent cut–off for both BMI and WC, as Indians are more prone to cardiovascular risk factors and metabolic syndrome.[15,19] In a study by Misra et al, it was found that, though in male subjects, a WC cutoff point of 90 cm (sensitivity 90.1%, specificity 83.6%), and in female subjects, a cutoff point of 80cm (sensitivity 92.3%, specificity 76.8%) was good enough for identifying those with a BMI ≥25 kg/m^2 but it had showed a lower sensitivity (49.7% in male and 50.3% in female) in identifying those with at least one cardiovascular risk factor.[19] In the same study, it was shown, for identifying those with BMI ≥23 kg/m^2, the current WC cut-off had sensitivity 78.8% & specificity 93.2% for males and sensitivity 85.2% & specificity 84.9% for females.[19] Midha et al in her study in Kanpur, India estimated that, the cut-offs for waist circumference for predicting hypertension were ≥83 cm for men and ≥78 cm for women.[20]

In India, Government of India initiated a National Programme for Prevention and Control of Cancers, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) only during 2010-11. Weight management is important since overweight and obesity are closely associated to cardiovascular risk, diabetes, cancer and mortality. Moreover, weight management is less costly than costs of treatment for obesity related diseases.[21] A consensus statement generated by a group of medical experts in 2009 suggested the BMI classification for Asian India population as normal BMI: 18.0-22.9 kg/m^2, overweight: 23.0-24.9 kg/m^2, obesity: >25 kg/m^2.[15] But, in latest National Family Health Survey-4 (2015-16) of India, for assessment of overweight or obesity, a key health indicator, BMI ≥25kg/m^2 was used.[22] If WC measurements are to be used as a single screening tool for identification of overweight and obesity in Indian adults; a less sensitive WC will leave a large proportion of overweight and obese subjects undiagnosed and thus unaware of the health risk. *Therefore, we suggest a higher sensitivity (which also means higher false positive rate), while minimizing the false negative rate as much as possible in determining the appropriate WC cut-off point because there is relatively less harm in recommending the false positive group for weight management (plagiarism.)* In addition, it will make the false positive group aware of the risks of further weight gain.

Our results showed that for men, 86.5 cm WC cut-off has a better diagnostic accuracy with sensitivity 86.4%, specificity 77.8% and Area under curve (AUC) (0.90; 95% CI 0.84–0.96) and for women, 78.5 cm WC cut-off has a better accuracy with sensitivity 83.3%, specificity 48.5% and Area under curve (AUC) (0.78; 95% CI 0.72–0.85); which are lower than the currently recommended WC cut off of 90 cm for men and 80 cm for women. We used BMI classification for Indian population (overweight or obese ≥23 kg/m^2) as gold standard. In a study by Misra et al.[19] WC cut-offs, 72 cm in women (sensitivity: 68.7%, specificity: 71.8%) and 78 cm in men (sensitivity: 74.3%, specificity: 68.0%) were observed to be optimum for identifying those with presence of at least one cardiovascular risk factor. WC cut-offs of ≥90 cm in men and ≥80 cm in women identified high odds ratio (4.2 and 2.2, respectively) for cardiovascular risk factors and those with a BMI ≥25 kg/m^2.[19] Misra et al have suggested two WC cut-off i.e action level 1: 78 cm (men) and 72 cm (women), those who should avoid gaining further weight and action level 2: 90 cm (men) and 80 cm (women), those who should seek medical help so that obesity-related risk factors could be investigated and managed.[15]

Waist circumference is a simple, easily measurable anthropometric parameter, which can be assessed in the outpatient setting as well as during field surveys. It requires only a non-stretchable measuring tape which is in expensive and easy-to-carry. During home visit, the field level health workers can easily monitor nutritional status of the community and make them aware of the risk of further gaining weight. Moreover, WC is easy to self-monitor also.

There were few limitations in our study. The sample size was small. In the present study, we determined the sensitivity of WC based on BMI classification as the gold standard. Hence, the sensitivity of WC cut-offs are highly dependent on the validity of the BMI cut-off points. However, we have shown WC cut-off for both WHO classification and Asian Indian classification as literature reviews have shown that the Asian population should have lower BMI cut-off points compared to European populations.[15,19,23,24] Furthermore, Asian Indians are at risk of developing obesity related co-morbidities like cardiovascular disease, diabetes at lower levels of BMI and WC.[15] The sensitivity of WC may also be influenced by the prevalence of overweight in the studied population.

CONCLUSION

Our study aimed to assess the sensitivity and specificity of WC as a screening tool for identifying overweight and obese and also to determine appropriate WC cut-offs for rural population of India for the same. We conclude that, WC can be used as screening tool identifying overweight and obesity as it showed more than 80% sensitivity. We recommend that, it can be used in National Family Health Surveys (NFHS) also. We suggest lower WC cut off (86.5 cm for men and 78.5 cm for women) than currently recommended WC cut-off for screening of overweight though further research on bigger sample size is needed to optimize the WC cut-off for identification of those with increased risk of overweight and obesity related diseases, so weight management can be started earlier. This will help in tackling the escalating burden of T2DM and cardiovascular disease in India.

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