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VALIDITY OF BODY MASS INDEX FOR PREDICTING OVER WEIGHT AND OBESITY IN INDIAN RURAL WOMEN

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ABSTRACT

Abdominal adiposity and impending epidemic of non communicable disease in Indians call for revisiting cut off values of BMI. Objectives of the study is [a] to assess nutritional status of rural women in India on the basis of BMI and waist hip ratio (WHR), [b] to examine validity of BMI against WHR. A community based cross sectional study. 610 rural women of reproductive age (15-49 years) are subjects of this study. After obtaining consent for participation, each study subject was subjected to weight, height, waist circumference, and hip circumference recording. Their WHR and BMI were computed using standard formulae. Measures of validity, ROC curve and AUC were computed for inferential purpose. Extent of CED was 19.67%. Over weight/ obese subjects were 26.56% (Asian criteria) and 16.07% (Global criteria). Taking WHR as gold standard, maximum number of sensitivity and specificity was obtained at the cut off 22.3 kg/m2 of BMI. The AUC was 0.73 (0.67-0.79) at 95% Confidence Interval (CI). Problem of under nutrition and over nutrition exists simultaneously in the rural women of reproductive age group. The WHO cut off value of BMI (23kg/m2) for detecting over weight/obesity be lowered to 22kg/m2.

Key words: Body Mass Index, obesity, overweight, waist circumference.

INTRODUCTION

Over weight and obesity has emerged a major disorder associated with many metabolic diseases in both developed and developing countries. Globally it is predicted that by 2020 non-communicable diseases will contribute to 80% of the global burden of disease causing 7 out of 10 deaths in developing countries. In comparison to less than 50% of the current figure this will be a significant change (Boutayeb, 2013). Obesity is an independent risk factor for cardio vascular disease (CVD) (Seidell ET.AL., 1996). It always correlates with CVD risk factors and type 2 diabetes mellitus (Kopelman, 2004). It has been observed that many Asian Indians fit into the categories of metabolic obese, normal weight Individuals. Asian Indian phenotype is characterized by [a] less of generalized obesity which is measured by Body Mass Index (BMI) and [b] greater waist circumference (WC) and Waist to Hip Ratio (WHR) (Joshi, 2013). In comparison to white populations (Mckeigue et.al., 1991 and Chandalia et.al., 1999) the risk association with cardio vascular and diabetes occurs at lower levels in Asian populations. For a given BMI they have higher upper body adiposity and higher visceral fat when compared with the western population.

While direct assessment of fat mass may be a better index of obesity-related to health risk, it is difficult to measure this accurately in large epidemiological studies particularly in the field setting. Anthropometry in terms of weight and height recording has been most commonly employed method for assessing nutritional status of adult population. It provides basis for computing BMI. BMI is a simple measure and most commonly used parameter to characterize a person as being undernourished, normal or overweight (pre obese and obese) (WHO, 2000). BMI, WC, WHR are used to define obesity. However the debate as to which is the best to assess this condition is still unresolved. The medical risks due to obesity have been shown to be linked more to the abdominal distribution of fat (Lapidus et.al., 1984 and Lean et.a*l.*, 1995). Realizing the fact that in Indian Maturity Onset Diabetes mellitus of Youth (MODY) and CVD are occurring at earlier age and giving due consideration to impending unprecedented rise in occurring of these diseases in Asian region lower cut off values for nutritional parameters has been suggested for Asians (Dudeja *et.al.*, 2001). For Singaporean female adults, the cut-off points of anthropometric indices as screening tools for CVD factors were lower than the criteria suggested by the WHO, but were in agreement with those reported for Asians. BMI, WHR, WC and WSR may be used as screening tools for cardiovascular risk factors. BMI may not correspond to the same body fat in different populations. There is enough scientific evidence that the ideal BMI may differ for different populations. In urban Asian Indian subjects even minor changes in BMI could tilt metabolic balance towards hyperglycemia (Yong-Hao and Peck-Hoon, 2005).

Although no single obesity index can be labeled as predictor of non-communicable diseases (NCD), BMI is considered is of least importance on scientific scrutiny whereas WHR is being increasingly recognized as a measure of obesity and thereby predictor of risk factors for NCDs. Therefore, there is need and scope for validation of BMI against WHR as a screening tool for overweight and obesity. There is genetic predisposition to obesity. However, major precipitating factor is

environmental (Yusuf *et.al.*, 2005 and Krangelund, 2005). With this background this study was contemplated in the eastern region of Utter Pradesh state, India with the following objectives: [a] To asses nutritional status of rural women on the basis of BMI and WHR. [b] To examine validity of BMI against WHR (Jellife, 1966).

MATERIAL AND METHODS

SETTING

This study was conducted in rural areas of Varanasi. This district is often called cultural capital of India. This district lies in the eastern part of Utter Pradesh state. Total population of district is 3682194 of which 56.57 % is rural. The literacy rate of district is 77.05% (male 85.12% female 68.20%). The overall sex ratio for the district is 909 (census 2011).

PERIOD OF STUDY

This study was carried out for a period of one year (April 2010-March 2011).

STUDY DESIGN

A community based cross sectional design was adopted for this study.

STUDY SAMPLE

Women of reproductive age group (15-49 years) were considered for this study. Pregnant and seriously ill women were excluded. Total sample size was fixed at 600. However 610 subjects were included in this study.

SAMPLE SIZE

Computation of required sample size of 576 was based on the assumption that prevalence of chronic energy deficiency (CED) in the rural reproductive age group women around 40% and permissible level of error as 10% of the prevalence rate.

SAMPLING METHODOLOGY

The required sample size was selected by adopting multi stage sampling. Following steps were involved in the selection of study subjects.

[a] One commisionary of Utter Pradesh state (comprising of 7 districts) was selected randomly.

[b] One district (viz. Varanasi) from the selected commisionary was selected by simple random sampling.

[c] One block (viz. Chiraigaon) out of 8 Community Development blocks from rural Varanasi was selected by simple random sampling.

[d] Five villages out of 84 villages of selected block were selected by systematic random sampling.

[e] Every seventh household from the selected villages were selected by systematic random sampling.

[f] From each household one study subject was selected.

APPROVAL OF THE STUDY AND CONSENT OF PARTICIPANTS

The study had prior approval of the academic bodies of Banaras Hindu University, Varanasi, India and prior consent was taken from the study subjects for participation in this study.

TOOLS OF STUDY

Portable weighing machine was used for weight recording and its accuracy machine was checked from time to time against known weights. Steel anthropometer rod with parallel bars having accuracy of 0.1 cm was used for height recording. Unstrechable measuring tape was used for taking waist and hip measurements.

TECHNIQUES OF STUDY

Each study subject was subjected to anthropometry (weight, height, WC and HC recording) following standard technique. All study subjects were weighed with minimum possible clothing and no foot wear on weighing machine with 0.1 kg precision. Zero error correction was done before taking the weight of each individual. The accuracy of the weighing machine was verified periodically by cross checking with a standard machine as well as by using standard weights.

The height of the subjects was recorded using steel anthropometer rod with parallel bars. The accuracy of the instrument was nearest 0.1 cm, with respondents standing erect with head, shoulder, buttocks, and heel vertically aligned against the rod without their foot wears. All precautions were taken during recording of height (Jellife, 1966).

The waist circumference was measured at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest with the help of unstrechable measuring tape that provided a constant 100 g tension[17] and Hip circumference was measured around the widest portion of the buttocks, with the tape parallel to the floor (WHO, 2008).

QUALITY ASSURANCE OF DATA

Data pertaining to 5% of samples were cross checked by the other researcher.

ANALYSIS OF DATA

Data thus collected was entered in personal computer. Statistical Package for Social Sciences (SPSS 16th version) and Microsoft Excel (2007 version) was used for analysis. BMI of each subject was computed by weight in kg/height in m^2 and this was used for nutritional grading by following the criteria suggested by WHO for both Global and Asian population. WHR of each study subject was computed and the subject was labeled as low or high risk by taking the cutoff point of 0.85. Taking WHR as gold standard, measures of validity [viz. sensitivity, specificity, positive productive value (PPV), and negative predictive value (NPV)] were computed for different cut off values of BMI. The ROC curve was plotted using measures of sensitivity and 1-specificity. The overall

performance of ROC curve was evaluated by calculating the area under the curve (AUC) with 95% Confidence Interval (CI).

RESULTS

Nutritional Status of the study subjects based on BMI (Asian and Global Classifications) is given in Figure-1 (A) and (B). By both the classifications, 120 (19.67%) subjects were categorized as victims of CED and 26.56% (Asian criteria) and 16.07% (Global criteria) were either overweight or obese. There was significant association (table -1) between WHR (cut off value 0.85) and BMI (cut off value 23). Out of 610, 63 (10.33%) subjects had WHR ≥0.85 and were characterized as obese/high risk for non communicable diseases (NCDs). Of these 30 (47.62%) and 33 (52.38%) were categorized as high (BMI ≥23kg/m^2) and non obese/low risk (BMI <23 kg/m^2) respectively. Out of 547 subjects with WHR <0.85 (non obese/low risk), 415 (75.87%) and 135 (24.13%) were labeled as non obese/low and obese/high risk on the basis of BMI. Out of 162 subjects with BMI ≥23kg/m^2, 30 (18.52%) and 132 (81.48%) subjects were characterized as obese/high and non obese/low risk on the basis of WHR. Of 448 subjects having BMI <23 kg/m^2, 33 (7.37%) and 415 (92.63%) were characterized as obese/high and non obese/low risk on the basis of WHR.

Table: 1 Waist Hip Ratio (WHR) versus Body Mass Index (BMI) based on Asian Classification.

BMI (Kg/M^2)	WHR				Total	
	≥0.85 (High Risk)		<0.85 (Low Risk)			
	No.	%	No.	%	No.	%
≥23	30	47.62	132	24.13	162	27.05
<23	33	52.38	415	75.87	448	72.95
Total	**63**	**100.00**	**547**	**100.00**	**610**	**100.00**
X^2=15.98; df= 1; p= 0.000						

Sensitivity = 47.62% Specificity = 75.87% PPV = 18.52% NPV = 92.63%

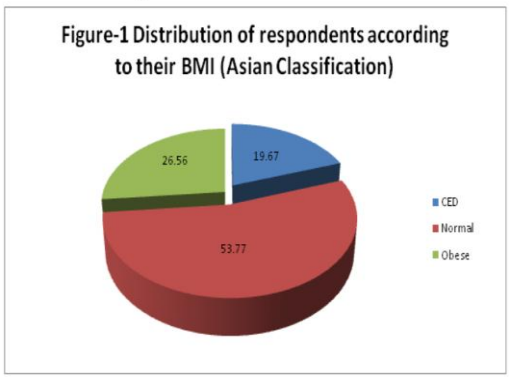
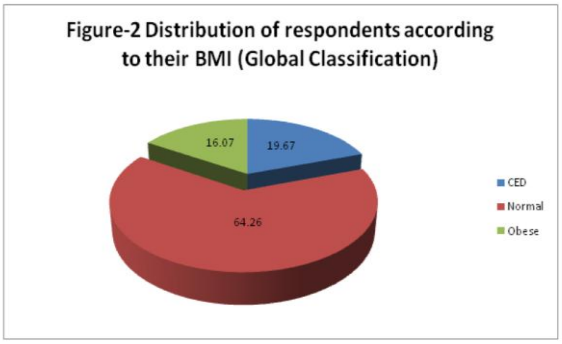


Table: 2 Waist Hip Ratio (WHR) versus Body Mass Index (BMI) based on Global Classification

BMI (Kg/M^2)	WHR				Total	
	≥0.85 (High Risk)		<0.85 (Low Risk)			
	No.	%	No.	%	No.	%
≥25	25	39.68	73	13.35	98	16.07
<25	38	60.32	474	86.65	512	83.93
Total	**63**	**100.00**	**547**	**100.00**	**610**	**100.00**
X^2=29.06; df= 1; p= 0.000						

Sensitivity = 39.68% Specificity = 86.65% PPV = 25.51% NPV = 92.58%



There existed significant association (table-2) between WHR of the same cut off value and BMI (cut off value 25). Out of 610 the percentage for over weight/obesity thereby high risk for NCDs was 10.33% taking cut off of WHR at 0.85 but out of 63 such subjects 25 (39.68%) and 38 (60.32%) were categorized as high (BMI ≥25kg/m^2) and low risk (BMI <25 kg/m^2) respectively. Similarly out of 547 subjects with WHR <0.85 (low risk), 474 (86.65%) and 73 (13.35%) were labeled as low and high risk on the basis of BMI. Out of 98 subjects with BMI ≥25kg/m^2, 25 (25.51%) and 73 (74.49%) subjects were characterized as high and low risk on the basis of WHR. Of 508 subjects having BMI <25 kg/m^2, 38 (7.42%) and 474 (92.58%) were characterized as high and low risk on the basis of WHR.

Taking WHR as Gold Standard and its cutoff value as 0.85, measures of validity of BMI at different cut off levels were computed and are given in table-3. Sensitivity increased with decreasing cut offs of BMI being least

(39.68%) at 25 and maximum (77.78%) at 21. Reversed trend was observed for specificity; its values at cut off of BMI 25 and 21 were 86.65% and 56.85% respectively. The table-3 depicts that cut off of 22 for BMI gives optimum combination of sensitivity (68.25%) and specificity (68.55%) against the gold standard of WHR for identifying subjects with over weight and obesity. high and low risk for non communicable diseases. The results given in table- 3 points that NPV is high for different cut offs of BMI. Whereas reverse situation prevailed for PPV.

Table: 3 Validity of BMI at different cut off values against WHR (cut off value 0.85)

BMI Cut Off	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
25	39.68	86.65	25.51	92.58
24	41.27	83.18	22.03	92.48
23	47.62	75.87	18.52	92.63
22	68.25	68.55	20.00	94.94
21	77.78	56.85	17.19	95.69

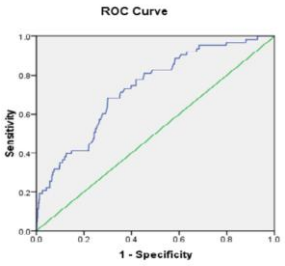


Figure- 3 BMI versus WHR

The ROC curve analysis allows visual evaluation of the trade-offs between sensitivity and specificity associated with different values of the test result (figure-3). Maximum sum of sensitivity and specificity was obtained at the cut off of 22.3 kg/m^2 of BMI. The area under the curve was 0.73 (CI at 95%: 0.67-0.79).

DISCUSSION

There are several evidences to show that rural women are in disadvantaged position and due to variety of reasons they become victim of CED. Contrary to observations of NFHS 2 (36.5%) (IIPS, 1998-1999) and NFHS 3 (37.2%) (IIPS, 2005-06) lower prevalence of CED has been observed in this study. This could be attributed to developmental status of the study area, status enjoyed by women, intra familiar food distribution and socio-cultural context as well as work profile. Other influencing factors may be peri-urban influence of Varanasi city, shifting trends towards sedentary life and activity pattern towards sedentary life and less farm activity due to decreasing per family land holding and changing agricultural practices. On the contrary prevalence of overweight and obesity has shown arising trend in comparison to findings of NFHS.

There is sufficient scientific evidence to warrant revision of WHO cut off values for various indices of overweight and obesity. A study conducted in Singapore compared cut off values of obesity for different parameters with the cardio-vascular risk pointed the cut off value for BMI and WHR as 23.6kg/m^2 and 0.8 WHR (Yong-Hao, 2005).

There is enough scientific evidence to substantiate that many Asian Indians fit into metabolically obese normal weight individuals. Anthropometric indices BMI, WHR and WC correlate well with diabetes mellitus, hypertension and metabolic syndrome. However WHR has similar association with dyslipidemia (Gupta et., 2007). The risk of diabetes was significant at BMI >23 kg/m^2 for urban and Indians of both sexes. An increasing trend with BMI >22 kg/m^2 had been indicated in previous study. [22] Even several international studies [have] suggested cut off for BMI as 22 (Daniel et.a, 2007, Akanuma, 1996 and Zhou, 2002).

It is not easy to assess CV risks (viz hypertension dyslipidemia and type 2 diabetes) in community settings realizing that strong association prevail between CV risk factors and obesity. Obesity can be taken as proxy indicator for CV risks. Several indices (BMI, WHR, WC, and WSR) are used for obesity (Hsieh *et.al.,* 2003). However yield of any screening programme depends on the cut off values used for them WHO has suggested cut off values for BMI ≥25 for overweight and ≥30kg/m^2 for obesity and WHR as 0.85 for female for global use. The debate about the potential of best predictor of anthropometric parameters in predicting risk for non communicable diseases is not settled as it but INTERHEART STUDY had mentioned that WHR is the best predictor for CVD events. Given optimum opportunities for development there is no reason that Indians will have lesser WHR than global standard. With this back ground cut off for WHR has been taken at 0.85. Therefore In this study WHR is taken as gold standard and sensitivity specificity of BMI in identifying people at high risk has been computed at different cut off levels (Gupta, 2007).

It is obvious from the results of this study that cut off BMI 22 is best suited for the study subjects rather than 23 suggested by Asian Classification of WHO. This is based on the consideration of ROC curve and AUC, which is a measure of the diagnostic power of a test, and describes the probability that a test will correctly identify subjects with the disorders. Similar views have been expressed by several researchers. Even migrant studies have suggested the cut off value of 22 for BMI for Asian Indians.[28, 29] However it should be noted that if a person is not over weight/ obese by BMI there is more than 90% probability that the judgment is correct (Dudeja, 2001 and Singh *et.al.,* 1992).

In the fitness of the things Government of India has given due emphasis on prevention and management of

non- communicable disease. Findings of this study have relevance in this endeavor. In fact emphasizing preventing measures taking cut off of BMI at 22 is desirable. However, this does not undermine the importance of operational ease in calculating WHR at field level. Thus Problem of under nutrition and over nutrition exist simultaneously in the rural women of reproductive age group. The WHO cut off value of BMI (23kg/m^2) for detecting over weight/obesity be lowered to 22kg/m^2.

CONCLUSION

Problem of under nutrition and over nutrition exists simultaneously in the rural women of reproductive age group. The WHO cut off value of BMI (23kg/m2) for detecting over weight/obesity be lowered to 22kg/m2.

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