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Comparison between three Different Diagnostic Criteria in Evaluating Metabolic Syndrome: An Experience from College Students of Kolkata, India

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INTRODUCTION

The main cause of mortality in India is attributed to cardiovascular diseases (CVDs).^[1] CVD results mainly due to metabolic risk factors.^[2] The constellation of key metabolic risk factors, namely insulin resistance, glucose intolerance, low high-density lipoprotein (HDL)

ABSTRACT

Background: Metabolic syndrome (MS) is gradually surging particularly among Asian Indians. Documented data on comparative studies based on different definitions with respect to MS prevalence among college students are few. **Aim:** The aim of this is to find the validity and degree of agreement between three different diagnostic criteria recommended by the International Diabetes Federation (IDF), the National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III), and the Consensus definition for Asian Indians (CDAI). **Materials and Methods:** A cross-sectional study was conducted among 477 college students aged 18–24 years of Kolkata selected by systematic random sampling from August 2011 to December 2014. Three different criteria, i.e., IDF, NCEP-ATP III, and CDAI, were used. Individuals signed a consent form before the study. Using IDF as a reference standard, validity of other criteria was measured by sensitivity and specificity. Cohen’s kappa (κ) coefficient was used to identify the degree of agreement between three different definitions. Statistical analysis was performed using SPSS software, version 19.0. $P \leq 0.05$ was considered statistically significant. **Results:** The prevalence of MS among college students was highest using the CDAI criteria (5.7%), followed by the IDF criteria (4.5%) and the NCEP-ATP III criteria (2.9%) being significantly higher in females ($P \leq 0.05$). Using IDF as a reference standard, the sensitivity, specificity, positive predictive value, negative predictive value, and likelihood ratio of positive test for CDAI were 100%, 98.9%, 81.5%, 100%, and 90.9, respectively; whereas, for the NCEP-ATP III criteria, these were 45.5%, 99.1%, 71.4%, 97.4%, and 50.56, respectively. IDF presented “almost perfect” agreement in relation to the CDAI with κ of 0.892 (95% CI: 0.798–0.986, $P = 0.000$) and “moderate” agreement with respect to the NCEP-ATP III criteria with κ of 0.539 (95% CI: 0.339–0.739, $P = 0.000$). **Conclusion:** At least 2.9% of the Kolkata college students studied had MS. The CDAI criteria were superior to the NCEP-ATP III criteria for predicting MS in this population, when compared with the IDF criteria.


KEYWORDS: Asian Indians, college students, criteria, Kolkata, metabolic syndrome

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cholesterol concentration, hypertriglyceridemia, hypertension, and abdominal obesity based on different formal definitions by various authorities is termed metabolic syndrome (MS).^[3-5] The prevalence of MS varies markedly between different studies because of the lack of an international consensus for its definition although essential components are the same but often cutoff values are different and have varied mandatory inclusion criteria.^[6] Increased prevalence and lowered age for the onset of MS are on rise among South Asians.^[7] It may be due to Asian Indian phenotype with body composition features of having excess body fat with respect to skeletal muscle mass, low body mass index, higher magnitude of abdominal fat mass, higher waist-to-hip ratio, and truncal subcutaneous fat^[8] in comparison to Caucasians. Westernization of diet also has a contributory role.^[9] This age group of young college students is usually underestimated as per the clinical condition of MS is concerned.

With increasing burden of MS worldwide, several organizations have framed clinical criteria for the diagnosis of MS. In 2001, National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III, 2001) proposed an updated definition of MS with a focus on primary prevention of CVD. Equal weightage was given to all “lipid and nonlipid” parameters with the notion that all components posed an equivalent risk and their clustering will further increase the future risk of development of type 2 diabetes mellitus (T2DM) and CVD.^[10] The NCEP-ATP III definition is diagnostic friendly being able to be carried out in a simple laboratory, but its applicability in risk prediction of CVD and T2DM is questionable and has been shown to underdiagnose insulin resistance.^[11] The International Diabetes Federation (IDF) in 2005 proposed a single worldwide definition of MS which facilitates international comparisons of data in clinical and research purposes.^[5] In the conceptual framework, the IDF definition emphasized on ethnic-specific threshold of waist circumference (WC) which is the mandatory criterion, and cutoffs of WC were lowered in both genders.^[12] Literature suggest that Asian Indians exhibit higher morbidity at much lower values of WC than Caucasians.^[13,14] In the IDF criteria, cutoff value of fasting blood glucose (FBG) was also lowered to 100 mg/dl at par with the American Diabetes Association’s new lower cutoff value of impaired fasting glucose (IFG),^[15] as insulin resistance is the underlying factor which culminates to CVD. The IDF criteria are now being widely used in epidemiological studies to gather evidence.^[16,17] Misra *et al.* suggested a modification of the IDF criteria and termed it “consensus definition for Asian Indians” (CDAI, 2009) to provide guidelines in detection of MS specifically for Asian Indians. Abnormality of any three components out of five

components was diagnostically defined as MS according to the CDAI criteria.^[18] Cutoffs were similar to IDF, but there was no obligatory criterion. The use of different criteria to investigate MS leads to differences in the prevalence of MS in the same population.^[6]

The prevalence of MS among college students of Kolkata has been reported earlier.^[19] However, epidemiological studies involving the comparison between three criteria to diagnose MS have not been done earlier in Kolkata. The purpose of the study was to examine and compare the prevalence of MS among college students (both boys and girls) aged 18–24 years of Kolkata using different diagnostic criteria.

MATERIALS AND METHODS

This was a cross-sectional epidemiological study; 477 students aged 18–24 years were recruited by systematic random sampling from ten-degree colleges in Kolkata city and suburban areas. Unwilling students were excluded from the study. Students participated voluntarily and signed the consent form. The study protocol was approved by the Bioethics Committee for Animal and Human Research Studies, University of Calcutta (Ref. No. BEHR/1098/2304 dated 22/06/11). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured by a standardized sphygmomanometer.^[20] Waist circumference measurement was made by a nonstretchable fiber plastic tape.^[21] Biochemical tests for FBG,^[22] serum HDL cholesterol,^[23] and triglycerides^[24] were done by standardized methods. For determining MS diagnostically, three criteria were employed: NCEP-ATP III,^[10] IDF (for Asians),^[5] and CDAI criteria.^[18] The key characteristics of these criteria are presented in Table 1. The IDF criteria for assessing MS were assigned “reference standard,” and comparisons were drawn separately with the NCEP-ATP III and CDAI criteria, respectively, in this study considering the vulnerability of Asian Indians to central obesity (CO).

Statistical analysis

The analysis was performed using Windows-based SPSS software, version 19.0 (Statistical Package for the Social Sciences Inc., Chicago, IL, USA). Categorical data were expressed in proportions. Continuous data were checked for normality by the Kolmogorov–Smirnov test. Cohen’s kappa (κ) statistics were used for finding the agreement between the three definitions of MS. $P \leq 0.05$ was considered statistically significant.

RESULTS

The prevalence of MS among college students of Kolkata was found to be 2.9%, 4.5%, and 5.7% according to the NCEP-ATP III, IDF, and CDAI criteria, respectively.

Table 1: Characteristics of diagnostic criteria for assessing metabolic syndrome

Definitions	CO, i.e., WC (cm)	Dysglycemia: FBG (mg/dl)	Hypertension (mmHg)	High triglycerides (mg/dl)	Low HDL (mg/dl)
NCEP-ATP III criteria, 2001 (any 3 of the following 5 features) ^[10]	Males >102, females >88	≥110	≥130/≥85	≥150	Males <40, females <50
IDF, 2005 (for Asians) (CO + any 2 other features) ^[5]	Males >90, females >80 (obligatory criterion)	≥100	≥130/≥85	≥150	Males <40, females <50
CDAI criteria, 2008 (for Asian Indians) (any 3 of the following features) ^[18]	Males >90, females >80 (nonobligatory criterion)	≥100	≥130/≥85	≥150	Males <40, females <50

CO: Central obesity, WC: Waist circumference, FBG: Fasting blood glucose, HDL: High-density lipoprotein, NCEP-ATP: National Cholesterol Education Program-Adult Treatment Panel, IDF: International Diabetes Federation, CDAI: Consensus Definition for Asian Indians

The absence of diagnostic concordance between different definitions poses confusion. The concordance and disparity between diagnoses using the NCEP-ATP III, IDF, and CDAI criteria among college students are presented in Tables 2 and 3, respectively.

Using the IDF criteria as “reference standard,” kappa statistics show that the CDAI is a better predictor of MS than the NCEP-ATP III criteria as there was “almost perfect” agreement between the CDAI and IDF criteria ($\kappa = 0.892$, 95% CI (0.798–0.986), $P = 0.000$), whereas there was a moderate agreement between the NCEP-ATP III and IDF criteria ($\kappa = 0.539$, 95% CI (0.339–0.739), $P = 0.000$) [Table 2].

The study revealed that 10 students with MS according to the definition of IDF had MS by the NCEP-ATP III definition as well (true positive), 12 students had MS as per the IDF definition but not by the NCEP-ATP III definition (false negative). Four hundred and fifty-one students fulfilled neither the IDF nor the NCEP-ATP III criteria. In consideration of the CDAI criteria, 22 students with MS according to the definition of IDF had MS by the CDAI criteria as well (true positive). Four hundred and fifty students fulfilled neither the IDF nor the NCEP-ATP III criteria [Table 3].

Moreover, the sensitivity of the CDAI criteria in detecting MS is 100% while that of the NCEP-ATP III criteria is 45.5%. The specificity values of the NCEP-ATP III and CDAI criteria were 99.1% and 98.9%, respectively. Other agreement statistics including positive predictive value (PPV), negative predictive value (NPV), likelihood ratio of positive test, and likelihood ratio of negative test indicate CDAI to be a better alternative to the IDF criteria in screening for MS than the NCEP-ATP III criteria [Table 3].

DISCUSSION

MS continues to amplify the public health burden in Asian Indians. However, data pertaining to MS among college students of Kolkata are rare. This study was designed to understand the difference in agreement

between three definitions of MS given by the NCEP-ATP III, IDF, and CDAI criteria in this population. In this study, the prevalence of MS was highest with the CDAI criteria (5.7%) followed by IDF (4.5%) and NCEP-ATP III (2.9%), thus exhibiting differential prevalence. Prevalence estimates are similar to reports of the pooled analysis involving multiple studies across varied ethnicities which suggested a 5%–7% prevalence of MS among college students worldwide.^[25] Discrepancies between different definitions could be explained by the fact that the prevalence of MS varied widely depending on the definition applied with different cutoff points for markers of CO and FBG. Moreover, the cutoff points of WC in the NCEP-ATP III criteria were primarily developed for Caucasians and might be inappropriate for Asian Indians^[26,27] which practically may have led to the exclusion of some metabolically deranged students.

High degree of concordance between the IDF and CDAI criteria was observed (Cohen’s κ coefficient = 0.892) [Table 2] which might be due the fact that the two definitions use the same five diagnostic components, and apart from WC (mandatory component in IDF), the remaining components along with their threshold levels are nearly identically defined. Moreover, both criteria emphasize Asian Indian ethnicity considerations.

Concordance between the IDF and NCEP-ATP III definitions was found to be moderate (Cohen’s κ coefficient = 0.539) [Table 2]. Possible explanation for this could be that NCEP-ATP III criteria was initially designed for risk prediction in Non-Asian Indian population and a wide gap exists between these two criteria in terms of WC cut off values. Moreover, recent data suggest that the NCEP-ATP III criteria cannot satisfactorily predict risk in Asian Indians.^[26,27] The NCEP-ATP III criteria give more priority to chronic metabolic conditions with equal weightage to all components, whereas IDF criteria emphasize more on abdominal obesity which gains importance in young college going population of Asian Indian origin. Hirani and Stamatakis conducted a study “Health Survey for England” among Chinese, Bangladeshi, Indian, and Pakistani (South Asian) men and general

population of the UK; they reported that South Asians had the highest prevalence of CO.^[28]

The sensitivity, specificity, PPV, NPV, likelihood ratio of positive test, and likelihood ratio of negative test of CDAI in diagnosing MS further explain its suitability over the NCEP-ATP III criteria [Table 3] for college students of Kolkata.

Published reports on the concordance between the diagnostic criteria for MS among college students are very rare. In a study carried out among university students in Fortaleza, Brazil, in 2017 by de Freitas *et al.*, the prevalence of MS was 0.7% and 4.1% according to the NCEP-ATP III and IDF criteria, respectively. A reasonable agreement (Cohen's κ coefficient = 0.294) between the IDF and NCEP-ATP III criteria was reported.^[29]

In a study among overweight and obese college students in Korea, carried out in 2010, by Cha *et al.*, 12% and 20% of the students were found having MS according to the NCEP-ATP III and IDF criteria, respectively. Substantial agreement (Cohen's κ coefficient = 0.74) between the IDF and NCEP-ATP III definitions was found.^[30]

Till date, no study compared the IDF, NCEP-ATP III, and CDAI criteria to assess MS among college

students. However, a similar type of study was done among postmenopausal women of Singur, West Bengal, India, by Srimani and Chaudhuri^[31] which reported the prevalence of MS being highest by the CDAI criteria (40.52%) followed by the IDF criteria (32.76%) and 27.59% by the NCEP-ATP III criteria. Agreement statistics revealed that CDAI was the better predictor of MS than the NCEP-ATP III criteria. Thus, the importance of CDAI was similarly established with regards to our study which may be due to same ethnicity and locale.

Limitations

The present study was cross-sectional in design with a sample size of 477; large-scale prospective studies with a much higher sample size would provide much more definitive findings. Only three most commonly used criteria were compared between themselves without considering other criteria such as the World Health Organization, 1998; the European Group of Insulin Resistance, 1999; and the modified ATP III, 2005, in this study.

CONCLUSION

College students of Kolkata were found to be vulnerable to MS although the prevalence varied considerably according to the criteria used for diagnosis. Considering all the three criteria for determining MS, it can be said that at least 2.9% of the Kolkata college students studied were having MS. The CDAI criteria were established to be a superior predictor of MS over the NCEP-ATP III criteria in this population, when compared with the IDF criteria. Early detection, health promotion strategies, and positive motivation for good health need to be initiated in college and university settings.

Table 2: Agreement among three definitions of metabolic syndrome (n=477)

Criteria	κ	P	Agreement
IDF versus NCEP-ATP III criteria	0.539	0.000*	Moderate
IDF versus CDAI criteria	0.892	0.000*	Almost perfect
NCEP-ATP III versus CDAI criteria	0.670	0.000*	Substantial

*Significant $P \leq 0.05$. IDF: International Diabetes Federation, NCEP-ATP: National Cholesterol Education Program-Adult Treatment Panel, CDAI: Consensus Definition for Asian Indians

Table 3: Diagnosis of metabolic syndrome by International Diabetes Federation criteria and other criteria (National Cholesterol Education Program-Adult Treatment Panel III and Consensus Definition for Asian Indians) (n=477)

Diagnostic criteria and agreement	MS by IDF criteria			MS by IDF criteria		
	NCEP-ATP III criteria	MS +	MS -	CDAI criteria	MS +	MS -
Diagnostic criteria	MS +	10 (TP)	4 (FP)	MS +	22 (TP)	5 (FP)
	MS -	12 (FN)	451 (TN)	MS -	0 (FN)	450 (TN)
Agreement statistics	NCEP-ATP III criteria			CDAI criteria		
κ		0.539			0.892	
Sensitivity (%)		45.5			100.0	
Specificity (%)		99.1			98.9	
PPV (%)		71.4			81.5	
NPV (%)		97.4			100.0	
LR+		50.56			90.9	
LR-		0.55			0.00	

MS: Metabolic syndrome, MS+: MS positive, MS-: MS negative, TP: True positive, FP: False positive, FN: False negative, TN: True negative, IDF: International Diabetes Federation, NCEP-ATP: National Cholesterol Education Program-Adult Treatment Panel, CDAI: Consensus Definition for Asian Indians, PPV: Positive predictive value, NPV: Negative predictive value, LR+: Likelihood ratio of positive test, LR-: Likelihood ratio of negative test

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Conflicts of interest

There are no conflicts of interest.

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