Original Article

Prevalence of metabolic syndrome in Gwalior region of Central India: A comparative study using NCEP ATP III, IDF and Harmonized criteria

Senthil Kumar Subramani [a], Sunil Mahajan [a], Pratibha Chauhan [a], Dhananjay Yadav [b], Meerambika Mishra [c], Umamaheswari Pakkirisamy [d], G.B.K.S. Prasad [a, *]

[a] School of Studies in Biochemistry, Jiwaji University, Gwalior, Madhya Pradesh, India
[b] Department of Medical Biotechnology, Yeungnam University, Gyeongsan, Republic of Korea
[c] Department of Infectious Diseases and Immunology, College of Veterinary Medicine, University of Florida, United States
[d] The Academy of Nursing Sciences & Hospital, Gwalior, Madhya Pradesh, India

ARTICLE INFO

ABSTRACT

Background: The aim of this study is to determine the prevalence of Metabolic syndrome (MetS) in the people of Gwalior. Three criteria viz., National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria, International Diabetes Federation (IDF) criteria and Harmonized criteria for MetS were employed to assess the prevalence of metabolic syndrome in this region, their concordance with respect to this population was recorded.

Methods: The cross-sectional study involved the people, who had attended the Diabetes clinic at the Centre for Translational Research, Jiwaji University during 2015-2017. A total of 1190 participants within the age group of 20–79 years of either gender were included in the study. Anthropometric parameters, blood pressure, blood glucose and lipid profile of all subjects were assessed. Student's 't' test, Kappa statistics and Binary logistic regression model were used to analyze the data.

Results: The percentage of prevalent MetS was found to be 72.7, 50.2 and 53.9 following Harmonized criteria, NCEP ATPIII and IDF criteria respectively. The prevalence was found to be maximum in centrally obese female population, aged between 51 and 60 years with the presence of hyperglycemia and reduced HDL– C. Harmonized and IDF criteria showed good agreement (κ 0.85). Regression analysis showed that, high body mass index, hypertension and dyslipedimia were the most critical predictive risk factors of MetS.

Conclusions: Maximum prevalence of MetS was recorded when the Harmonized criteria was followed. A good agreement was observed between Harmonized vs. IDF criteria. MetS if detected early especially in apparently healthy subjects; paves way for preventive measures to be designed in order to avert the incidence of diabetes and other risks related to cardio vascular disease.

© 2018 Published by Elsevier Ltd on behalf of Diabetes India.

1. Introduction

The metabolic syndrome (MetS) is the clustering of risk factors that eventually leads to cardiovascular diseases (CVD), and the risk factors include, abdominal obesity, dyslipidemia, hyperglycemia and hypertension in an individual [1]. Around 20–25 per cent of the world's adult population have the MetS. Several studies have reported that, the prevalence of MetS is more than double in Type II Diabetes Mellitus (T2DM) subjects as compared to other disorders and are three times as likely to have a heart attack or stroke compared to people without the MetS [2–4]. Different diagnostic criteria have been recommended by various organizations like IDF, WHO, NCEP ATP III etc. Each criteria has different cutoff values for gender and ethnicity group for the diagnosis of MetS. Alberti et al. (2009) proposed the Harmonized criteria, to unify the combination of the criteria of various organizations viz., IDF, National Heart, Lung and Blood Institute, American Heart Association, World Heart Federation, International Atherosclerosis Society and International Association for the Study of Obesity [5].

South East Asians are at higher risk for MetS, around one out of five adult population are MetS positive and the numbers are steadily on the rise [6]. The huge burden of CVD in the Indian

Subcontinent is the outcome of the large population and high prevalence of CVD risk factors [7]. Earlier we have reported the comparison of 3 MetS criteria in T2DM subjects, the highest prevalence of metabolic syndrome (57.7%) was found when IDF criteria was followed and a good agreement between IDF and NCEP ATP III criteria was also seen [8]. Limited information exists regarding the burden of MetS among the apparently healthy and pre-diabetic population of Central India. Therefore, we aimed to determine the prevalence of MetS in the seemingly healthy and pre-diabetics along with diabetic subjects in Gwalior region, and the concordance of IDF [9], NCEP ATP III [10] and Harmonized criteria in this population.

2. Material and methods

2.1. Study area and subjects selection

The subjects involved in this study were patients who visited the Weekend diabetic clinic conducted at Center for Translation Research, Jiwaji University, Gwalior, Madhya Pradesh, India. The study was carried out from May 2015 to Nov 2017. A total of 1190 subjects of which 819 males and 371 females from 20 to 79 years of age were included in this study. All participants had been given the written consent for participation. The information about subject's age, sex, life styles and other diseases/disorders were recorded. Height, weight, waist circumferences and blood pressure (BP) were measured. Institutional human ethics committee at Jiwaji University, Gwalior, Madhya Pradesh (India) has approved the study protocol (No. JU/IHEC/2014/ 07).

2.2. Parameters monitored and methods

Blood sample (2 ml) was collected from each subject for the estimation of biochemical parameters such as blood glucose, total cholesterol, triglyceride and HDL- Cholesterol by commercially available kits (Corel, Tulip Diagnostics). LDL and VLDL were calculated using Freidewald's formula.

2.3. Criteria for metabolic syndrome

Criteria used for defining MetS and their cutoff points are shown in Table 1.

2.4. Data analysis and risk prediction

Descriptive statistics such as percentage (%), mean and standard deviation (SD) were used to describe the data. Kappa (κ) statistics was used for finding the agreement between the different criteria. ANOVA, Student's 't' test were used to test the associations between metabolic and non metabolic syndrome group. Stepwise binary logistic regressions model used to find the risk factors related to prevalence of metabolic syndrome (SPSS version 20). The values were tested for significance at P < 0.05.

3. Result

3.1. Characteristics of study population

The mean age of the participants was 52.9 ± 10.97 years. When comparison was made between males and females, significant difference was observed in their age, fasting blood glucose, BMI, blood pressure, triglycerides and HDL cholesterol levels (Table 2).

3.2. Prevalence of metabolic syndrome

The prevalence of MetS was found to be 72.7%, 50.2% and 53.9% following the Harmonized criteria, NCEP ATP III and IDF criteria respectively.

The prevalence of MetS among the normal, pre-diabetic and diabetic subjects by using various criteria was assessed further. Based on Harmonized criteria, the prevalence was 39.6%, 80.5% and 83.5% in normal, pre-diabetic and diabetic subjects respectively. Whereas based on NCEP ATP III criteria, only 21.3% normal subjects, 48.9% pre-diabetic subjects and 64.9% diabetic subjects were diagnosed with MetS. Following IDF criteria, the incidence of MetS was 30.6%, 60.3% and 60.9% in normal, pre-diabetic and diabetic subjects respectively (Table 3).

Based on the gender, high prevalence of MetS was observed in the female population irrespective of criteria used. In females, the prevalence of Mets observed was 84.5% in Harmonized criteria, 64.5% in NCEP ATP III and 80% in IDF criteria in the age group of 50—59 years and the prevalence (27.3%) was similar by all criteria in the age group of 21 —30 years. While in the male population, 75% was observed byHarmonized criteria in the age group of 70—79 years, 46.6% in NCEPATP III in the age of 61—70 years and 52.5% in IDF criteria at the age of 41—50 years. We also observed that, the incidence rate was increased with age of the subject based on the Harmonized criteria, whereas this trend was not recorded by the other two criteria (Table 3).

3.3. Agreement among the NCEP ATP III, IDF and Harmonized criteria

Agreement among these three criteria of metabolic syndrome by kappa statistics is shown in Table 4. MetS + ve subjects as per Hormonized criteria also met the criteria of IDF by 81.18% (k = 0.61) and NCEP ATP III by 77.5%. (k = 0.549). Whereas, all participants diagnosed MetS by IDF criteria also met the Harmonized criteria. Good agreement was observed between Harmonized criteria and IDF criteria (k = 0.61). Lowest agreement was observed between IDF and NCEPATP III criteria (k = 0.445).

Venn diagram highlights the agreement of result by these criteria, Almost 52.5% (454) subjects are commonly diagnosed by the three criteria employed(Fig. 1).

Table 1
Definitions and cutoff points of MetS according to various organizations.

	Parameter/criteria	Harmonized criteria -2009	IDF-2005	NCEP ATP III-2001
	Prerequisites for diagnosing MetS	Any three of the following	Abdominal obesity along with any other two	Any three of the following
1	Waist Cir. (cm)	Men >90	Men >90	Men >102
		Woman> 80	Woman> 80	Woman> 88
2	Blood pressure (mmHg)	≥130/85	≥130/85	≥130/85
3	Fasting (mg/dl)	≥100	≥100	≥110
4	Triglyceride (mg/dl)	≥150	≥150	≥150
5	HDL-C (mg/dl)	Men < 40	Men < 40	Men<40
		Woman<50	Woman< 50	Woman< 50

Table 2
Demographic, anthropometric and biochemical variables of study population.

	Male (819)	Female (371)	Difference (p value)	All population
Age	53.5 ± 10.9	51.7 ± 11.0	1.79 (*)	52.92 ± 10.97
Waist Cir. (Inches)	36.1 ± 4.0	34.9 ± 4.3	1.19(**)	35.69 + 4.12
BMI (Kg/m2)	25.0 ± 3.9	26.9 ± 4.4	−1.83(**)	25.59 ± 4.14
Systolic pressure (mmHg)	127.9 ± 15.1	126.4 ± 14.7	1.46	127.45 ± 14.98
Diastolic pressure (mmHg)	80.7 ± 7.7	79.4 ± 7.6	1.33(*)	80.34 ± 7.66
Fasting (mg/dl)	137.8 ± 59.3	137.3 ± 55.1	0.48	137.68 ± 57.95
P.P (mg/dl)	196.2 ± 89.7	188.6 ± 80.1	7.65	193.84 ± 86.82
Total Cholesterol (mg/dl)	144.5 ± 34.0	149.3 ± 33.3	−4.77	146 ± 33.81
Triglyceride (mg/dl)	119.7 ± 27.9	131.6 ± 49.2	−11.84(**)	123.42 ± 36.3
HDL-C (mg/dl)	35.2 ± 7.7	37.1 ± 8.1	−1.85(**)	35.78 ± 7.83

Values are presented as mean ± standard deviation. p-values (* = <0.05 ** = < 0.001): Student's t-test was used to compare the mean values of biochemical and anthropometric characteristics between male and female study population.

Table 3
Prevalence of Metabolic syndrome in the study population.

		Harmonized criteria			NCEP ATP III criteria			IDF criteria		
		Male	Female	P value	Male	Female	P value	Male	Female	P value
Diabetes status	N	819	371		819	371		819	371	
	Normal	61 (37.9)	45(42.1)	0.525	26 (16.1)	31(29)	0.0147	41(22.5)	41(38.3)	0.0304
	{Total}	{106 (39.5)}			{57 (21.3)}			{82 (30.6) }		
	Pre Diabetes	211 (77.9)	87(87.9)	0.0373	127(46.9)	54(55.1)	0.1984	145(53.5)	78(78.8)	<0.0001
	{Total}	{298(80.5)}			{181(50.0)}			{223 (60.3)}		
	Diabetes	310(80.1)	151(91.5)	0.0007	223(57.6)	135(81.8)	<0.0001	197(50.9)	139(84.2)	<0.0001
	{Total}	{461 (83.5) }			{358 (64.8) }			{336 (60.9) }		
Age group	20–29 years	5 (33.3)	3(27.3)	>0.050	4(26.7)	3(27.3)	>0.050	2(13.3)	3(27.3)	>0.050
	30–39 years	61(70.1)	33(63.5)	>0.050	39(44.8)	23(44.2)	>0.050	28(32.2)	31(59.6)	<0.010
	40–49 years	160(72.1)	89(77.4)	>0.050	102(45.9)	71(61.7)	<0.010	117(52.7)	80(70.2)	<0.010
	50–59 years	195(70.7)	93(84.5)	<0.010	129(46.7)	72(64.5)	<0.010	133(48.5)	88(80)	<0.0001
	60–69 years	131(73.2)	55(78.6)	>0.050	84(46.9)	45(64.3)	<0.05	86(48.0)	47(67.1)	<0.05
	70–79 years	30(75)	10(83.3)	>0.050	18(45)	7(58.3)	>0.050	17(42.5)	9(75)	>0.050
	Sex specific prevalence	582 (71.0)	283 (89.2)	>0.050	376(45.9)	221(59.2)	<0.0001	383(46.7)	258(69.5)	<0.0001
	Total prevalence	865 (72.7)			597(50.2)			641 (53.9)		

Values are expressed as number (%), p-values (* = <0.05 ** = < 0.001): Student's t-test was used to compare the prevalence of metabolic syndrome between male and female population.

Table 4
Agreement among the different criteria in diagnosis of metabolic syndrome.

		Harmonized criteria 2009			Kappa (95% CI)
		MetS +	MetS-	Total	
IDF 2005	MetS +	641	0	**641**	0.61 (0.567–0.652)
	MetS -	224	325	**549**	
	Total	**865**	**325**	**1190**	
Harmonized criteria 2009					
NCEP ATP III criteria 2001	MetS +	597	0	**597**	0.549 (0.506–0.591)
	MetS -	268	325	**593**	
	Total	**865**	**325**	**1190**	
NCEP ATP III criteria 2001					
IDF 2005	MetS +	454	187	**641**	0.445 (0.394–0.496)
	MetS -	143	406	**549**	
	Total	**597**	**593**	**1190**	

Values are expressed as number of subjects.

3.4. Distribution of clinical data among the metabolic syndrome subjects according to different criteria

One way ANOVA was made to compare the mean of all demographic, anthropometric and biochemical variables between different criteria. There was no significant difference observed in the mean age groups, and HDL cholesterol level among the criteria thus compared. However, significant difference was observed in the mean of waist circumference and BMI by IDF compared to Harmonized criteria and NCEP ATP III criteria. Fasting blood glucose, PP blood glucose and total cholesterol levels were significantly differed from NCEP ATP III criteria compared to Harmonized and IDF criteria, whereas diastolic blood pressure and triglyceride were different between those of NCEP ATP III criteria and Harmonized criteria (Fig. 2).

3.5. Distribution patterns of abnormal components of metabolic syndrome among the subjects

Individual components and their combinations lead to MetS. The Harmonized criteria showed, the highest prevalence of 20.7% (179 subjects) in combination of central obesity, high blood
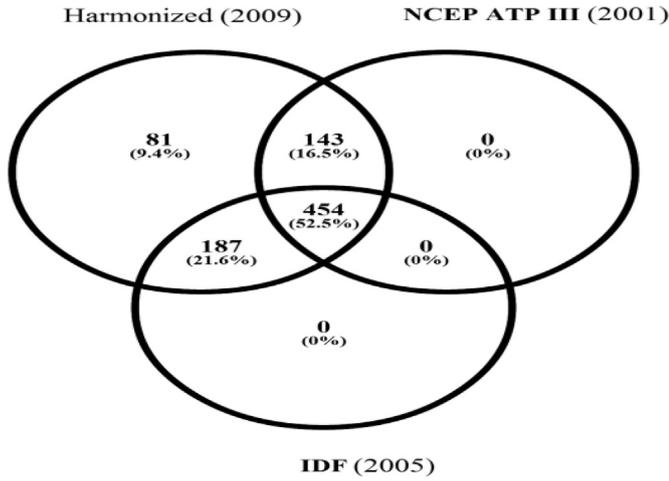
Fig. 1. Venn diagram showing the overlapping of subjects with metabolic syndrome based on the three definitions.

Fig. 3. Distribution patterns of MetS components in the study population. Number of individuals with abnormal parameter(s) by Hormonized crieteria.

pressure and low HDL cholesterol. Around 5.4% (133 subjects) were observed in the combination of central obesity, elevated sugar and low HDL cholesterol. Only 12.8% (111 subjects) observed in the combination of all abnormalities (Fig. 3).

3.6. Risk factors for MetS (Stepwise binary logistic regression model)

Table 5 shows the association of different variables in order of their entry into the regression equation in each group. Higher fasting blood glucose (RP 1.009 (95% CI: 1.006, 1.097)), systolic blood pressure (RP 1.082 (95% CI: 1.066, 1.097)) and BMI (RP 1.120 (95% CI: 1.053, 1.192)), waist circumference(RP 1.157 (95% CI: 1.087, 1.232)), triglyceride (RP 1.017 (95% CI: 1.011, 1.022)) and HDL Cholesterol (RP 0.910 (95% CI: 0.890, 0.931)) significantly increased the prevalence of MetS. Age, gender and diastolic blood pressure had no significant independent association with MetS when other covariates were considered in this study population.

4. Discussion

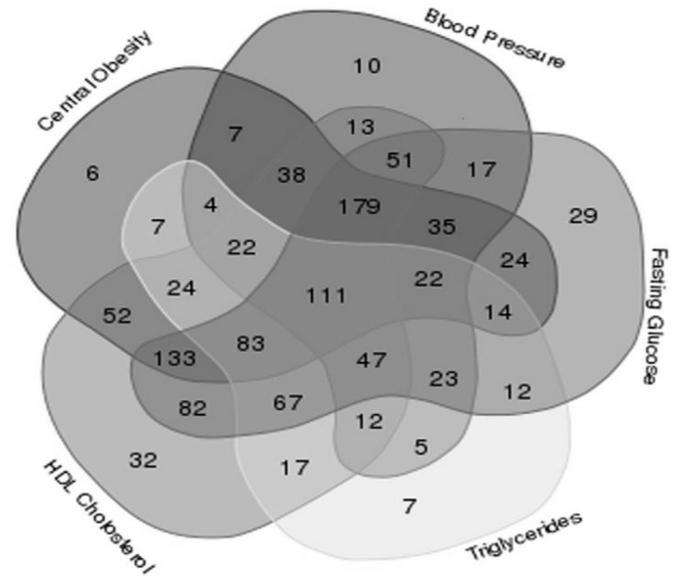In this cross-sectional study, three different criteria were used to

Table 5
Risk factors related to prevalence of metabolic syndrome in study population (Stepwise Binary Logistic Regression Model).

Variables	Odds ratio	95% CI
Waist circumference	1.157	1.087,1.232 *
BMI	1.120	1.053,1.192 *
Systolic blood pressure	1.082	1.066,1.097*
Fasting blood glucose	1.009	1.006,1.013*
Triglyceride	1.017	1.011,1.022*
HDL Cholesterol	0.910	0.89, 0.931*

*p-values * = <0.05.

assess the prevalence of metabolic syndrome in 1190 participants who attended the diabetes clinic for the first time at the Center for translational research, Jiwaji University. Among the study population, the highest prevalence rate was recorded by Harmonized criteria (crude: 72.7%, diabetic: 83.5%, pre-diabetic: 80.5% and normal subjects: 39.6%) followed by IDF criteria (crude: 53.9%,
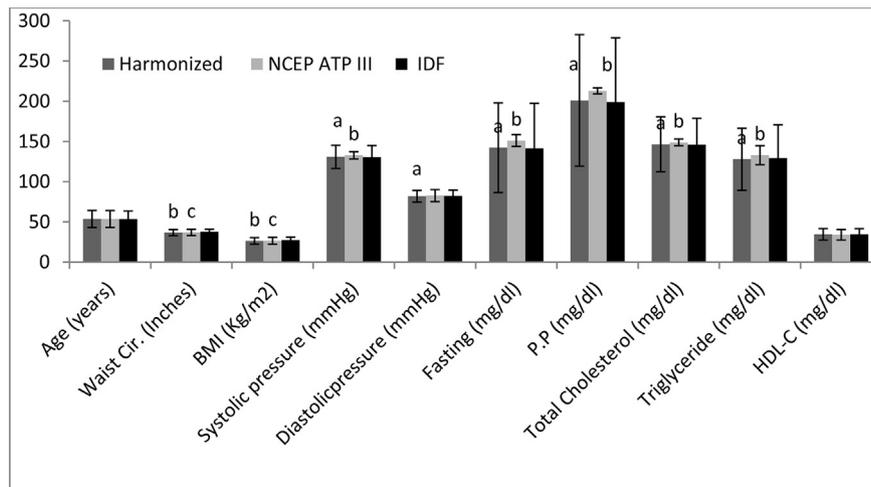

Fig. 2. Demographic, anthropometric and biochemical variables of subjects with MetS by various criteria- Comparative analysis. The mean difference is significant at the 0.05 level; "a" Significant between Harmonized criteria 2009 and NCEP ATP III, "b" Significant between Harmonized criteria and IDF, "c" Significant between NCEP ATP III and IDF.

diabetic: 60.9%, pre-diabetic: 60.3% and normal subjects: 30.6%) and NCEP ATP III (crude: 50%, diabetic: 64.9%, pre-diabetic: 48.9% and normal subjects: 21.3%). Irrespective of the defining criteria, this study revealed a very high prevalence of MetS than has been reported in our earlier study [8].

Numerous studies have been done worldwide with varying prevalence percentages [2,11,12]. Several studies have also been done in India to determine the prevalence of MetS [13–18]. Recent data show that, about one third of the urban population in India's major cities suffer from MetS [19].

Earlier studies in India used NCEP ATP III, IDF, WHO criteria for diagnosis of MetS and reported the prevalence of 18–57% in urban subjects [8,20–23]. Differences in prevalence rate may have arisen due to the diverse cut-off points and sets of parameters used by these criteria. Harmonized criteria showed the highest prevalence in all categories due to the removal of central obesity as an obligatory component, less cut-off point in glucose level, waist circumference and consideration of any three out of five parameters listed out for Harmonized criteria. Owing to the very high cut-off points for waist circumference and sugar level, NCEP ATP III criteria could identify relatively low number of patients with metabolic syndrome [24]. The major difference among these three criteria is the cut-off points of waist circumference and blood glucose.

Almost all (99%) the subjects had at least one abnormal biochemical or anthopormetric parameter leading to MetS; the prevalence of MetS in females was more than in males. High prevalence in female population may be due to the fact that majority of females in the region are occupied with usual household work (unpublished observation of our lab) and without any major physical excersise..This observation corroborates with that of others [17,25].

Increased prevalence of MetS (39.5%) in apparently healthy subjects is a risk factors for diabetes and CVD in near future. Recent study by Madan et al.(2017) also reported almost same prevalence of MetS in Mumbai [15]. Therefore, remedial measures starting from identifying potential MetS subjects, counseling on life-style changes are imperative [26]. Regular physical activity, avoidance of smoking and the consumption of fast food with saturated fats, simultaneously with an increased intake of fresh fruits and vegetables will preclude the individuals from MetS.

5. Conclusion

The prevalence of MetS was more in the study population by Harmonized criteria. A good agreement was seen between Harmonized and IDF criteria. MetS was high in diabetic subjects irrespective of criteria used. Increased prevalence of MetS among apparently normal subjects is much feared possibility of developing diabetes and CVD in near future. Periodic monitoring and early intervention particularly with lifestyle changes would delay the onset of complications associated with MetS.

Disclosure

The authors have no financial conflicts or anything of interest to disclose.

Acknowledgment

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dsx.2018.12.003.

References

[1] Eckel RH, Grundy SM, Zimmet PZ. The metabolic syndrome. Lancet 2005;365: 1415–28. https://doi.org/10.1016/S0140-6736(05)66378-7.

[2] Janghorbani M, Amini M. Metabolic syndrome in type 2 diabetes mellitus in isfahan, Iran: prevalence and risk factors. Metab Syndrome Relat Disord 2007;5:243–54. https://doi.org/10.1089/met.2005.0010.

[3] Nsiah K, Shang Vo, Boateng Ka, Mensah F. Prevalence of metabolic syndrome in type 2 diabetes mellitus patients. Int J Appl Basic Med Res 2015;5:133. https://doi.org/10.4103/2229-516X.157170.

[4] Tan MC, Ng OC, Wong TW, Joseph A, Chan YM, Hejar AR. Prevalence of metabolic syndrome in type 2 diabetic patients: a comparative study using WHO, NCEP ATP III, IDF and Harmonized definitions. Health (Irvine Calif) 2013;05:1689–96. https://doi.org/10.4236/health.2013.510227.

[5] Alberti KGMM, Eckel RH, Grundy SM, Zimmet PZ, Cleeman JI, Donato KA, et al. Harmonizing the metabolic syndrome: a joint interim statement of the international diabetes federation task force on epidemiology and prevention; national heart, Lung, and blood Institute; American heart association; world heart federation; international. Circulation 2009;120:1640–5. https://doi.org/10.1161/CIRCULATIONAHA.109.192644.

[6] Ranasinghe P, Mathangasinghe Y, Jayawardena R, Hills AP, Misra A. Prevalence and trends of metabolic syndrome among adults in the asia-pacific region: a systematic review. BMC Public Health 2017;17:101. https://doi.org/10.1186/s12889-017-4041-1.

[7] Goyal A, Yusuf S. The burden of cardiovascular disease in the Indian sub-continent. Indian J Med Res 2006;124:235–44. doi:2005.

[8] Yadav D, Mahajan S, Subramanian SK, Bisen PS, Chung CH, Prasad G. Prevalence of metabolic syndrome in type 2 diabetes mellitus using NCEP-ATPIII, IDF and WHO definition and its agreement in Gwalior chambal region of Central India. Global J Health Sci 2013;5:142–55. https://doi.org/10.5539/gjhs.v5n6p142.

[9] International Diabetes Federation. The IDF consensus worldwide definition of the metabolic syndrome. IDF Consens Worldw Defin Metab Syndr 2006;28: 1–7. https://doi.org/10.1159/000282084.

[10] NCEP Expert Panel. Executive summary of the third report of the national cholesterol education Program (NCEP) expert Panel on detection, evaluation, and treatment of high blood cholesterol in adults (adult treatment Panel III). J Am Med Assoc 2001;285:2486–97. https://doi.org/10.1001/jama.285.19.2486.

[11] Moy FM, Bulgiba A. The modified NCEP ATP III criteria maybe better than the IDF criteria in diagnosing Metabolic Syndrome among Malays in Kuala Lumpur. BMC Public Health 2010;10:678. https://doi.org/10.1186/1471-2458-10-678.

[12] Guo H, Liu J, Zhang J, Ma R, Ding Y, Zhang M, et al. The prevalence of metabolic syndrome using three different diagnostic criteria among low earning nomadic kazakhs in the far northwest of China: new cut-off points of waist circumference to diagnose mets and its implications. PLoS One 2016;11:1–13. https://doi.org/10.1371/journal.pone.0148976.

[13] Gupta R, Deedwania PC, Gupta A, Rastogi S, Panwar RB, Kothari K. Prevalence of metabolic syndrome in an Indian urban population. Int J Cardiol 2004;97: 257–61. https://doi.org/10.1016/j.ijcard.2003.11.003.

[14] Mahadik SR, Deo SS, Mehtalia SD. Increased prevalence of metabolic syndrome in non-obese Asian Indian—an urban-rural comparison. Metab Syndrome Relat Disord 2007;5:142–52. https://doi.org/10.1089/met.2006.0029.

[15] Madan J, Narsaria A. Prevalence of metabolic syndrome in Mumbai City, India. J Obes Metab Res 2016;3:16–22. https://doi.org/10.4103/2347-9906.184101.

[16] Nag T, Ghosh A. Prevalence of metabolic syndrome in rural elderly of Asian Indian origin. Am J Hum Biol 2015;27:724–7. https://doi.org/10.1002/ajhb.22697.

[17] Kamble P, Deshmukh PR, Garg N. Metabolic syndrome in adult population of rural Wardha, central India. Indian J Med Res 2010;132:701–5. doi:Indian-JMedRes_2010_132_6_701_75273.

[18] Ravikiran M, Bhansali A, RaviKumar P, Bhansali S, Dutta P, Thakur JS, et al. Prevalence and risk factors of metabolic syndrome among Asian Indians: a community survey. Diabetes Res Clin Pract 2010;89:181–8. https://doi.org/10.1016/j.diabres.2010.03.010.

[19] Misra A, Khurana L. The metabolic syndrome in South Asians: epidemiology, determinants, and prevention. Metab Syndrome Relat Disord 2009;7: 497–514. https://doi.org/10.1089/met.2009.0024.

[20] Deepa M, Farooq S, Datta M, Deepa R, Mohan V. Prevalence of metabolic syndrome using WHO, ATPIII and IDF definitions in Asian Indians: the Chennai urban rural epidemiology study (CURES-34). Diabetes Metab Res Rev 2007;23:127–34. https://doi.org/10.1002/dmrr.658.

[21] Ramachandran A, Snehalatha C, Satyavani K, Sivasankari S, Vijay V. Metabolic syndrome in urban Asian Indian adults - a population study using modified ATP III criteria. Diabetes Res Clin Pract 2003;60:199–204. https://doi.org/10.1016/S0168-8227(03)00060-3.

[22] Sinha S, Misra P, Kant S, Krishnan A, Nongkynrih B, Vikram NK. Prevalence of

metabolic syndrome and its selected determinants among urban adult women in South Delhi, India. Postgrad Med J 2013;89:68—72. https://doi.org/10.1136/postgradmedj-2012-130851.

[23] Pradeepa R, Surendar J, Indulekha K, Chella S, Anjana RM, Mohan V. Prevalence of metabolic syndrome and its association with coronary artery disease among an urban elderly South Indian population (CURES- 145). J Assoc Phys India 2016;64:20—5.

[24] Pokharel DR, Khadka D, Sigdel M, Yadav NK, Acharya S, Kafle RC, et al. Prevalence of metabolic syndrome in Nepalese type 2 diabetic patients according to WHO, NCEP ATP III, IDF and Harmonized criteria. J Diabetes Metab Disord 2014;13:104. https://doi.org/10.1186/s40200-014-0104-3.

[25] Prasad DS, Kabir Z, Dash AK, Das BC. Prevalence and risk factors for metabolic syndrome in Asian Indians: a community study from urban Eastern India. J Cardiovasc Dis Res 2012;3:204—11. https://doi.org/10.4103/0975-3583.98895.

[26] Sawant A, Mankeshwar R, Shah S, Raghavan R, Dhongde G, Raje H, et al. Prevalence of metabolic syndrome in urban India. Cholesterol 2011;2011: 1—7. https://doi.org/10.1155/2011/920983.