Journal of Global Diabetes & Clinical Metabolism

Research Article

Prevalence and Predictors of Metabolic Syndrome in a North Indian Rural Population: A Community Based Study

This article was published in the following Scient Open Access Journal:
Journal of Global Diabetes & Clinical Metabolism
Received July 30, 2016; **Accepted** August 26, 2016; **Published** August 31, 2016

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Abstract

Background: Metabolic Syndrome (MetS) is used worldwide as a tool to predict the future risk of development of Cardiovascular Disease (CVD) and Type 2 Diabetes Mellitus (T2DM). Prevalence of MetS is increasing globally and now it has started rising in the rural populations as well. Therefore realizing its significance, we determined the prevalence of MetS in a rural population.

Methods: 1700 subjects (males 818, females 882) with age ≥ 20 years were recruited from two districts of Haryana state. Socio-demographic data was collected by house to house survey of randomly selected subjects and anthropometric variables [height, weight, Waist-Circumference (WC), and hip circumference] including Blood Pressure (BP) were measured. Blood samples were collected after overnight fasting and analyzed for Fasting Plasma Glucose (FPG) and lipid profile.

Results: In our study, the prevalence of MetS was 26.6% (95% CI: 24.6 - 28.8%); higher in females (38.2%) than males (14.2%). Prevalence of components of MetS in females and males was as follows: increased WC, 51% and 19.3%; low HDL cholesterol, 88.7% and 32.3%; high triglycerides, 28.2% and 31.8%; raised BP, 47.7% and 52.1% and raised FPG, 42.4%, and 53.1% respectively. Waist height ratio (WHtR) was found to be the strongest predictor of MetS, followed by raised FPG, raised triglycerides, hypertension (HTN), high waist hip ratio (WHR), low HDL cholesterol, female sex and obesity.

Conclusions: There was a high prevalence of MetS in a rural population indicating towards impending epidemic of T2DM and CVD.

Keywords: Prevalence, Metabolic Syndrome X, Rural Population, India

Abbreviations: aOR: adjusted Odds Ratio; BMI: Body Mass Index; BP: Blood Pressure; CAD: Coronary Artery Disease; CVA: Cerebrovascular Accident; CVD: Cardiovascular Disease; FPG: Fasting Plasma Glucose; HDL: High Density Lipoprotein; HTN: Hypertension; ICO: Index of Central Obesity; LDL: Low Density Lipoprotein; MetS: Metabolic Syndrome; NCD: Non-Communicable Disease; SPSS: Statistical Package for Social Sciences; T2DM: Type 2 Diabetes Mellitus; TGs: Triglycerides; WC: Waist Circumference; WHR: Waist-Hip Ratio; WHtR: Waist-Height Ratio

Introduction

Metabolic Syndrome (MetS) is a cluster of the most dangerous cardiovascular risk factors: diabetes and raised fasting plasma glucose, abdominal obesity, high cholesterol and high blood pressure [1-4]. It is estimated that around 20-25 per cent of the world's adult population harbors the MetS. Their probability to die from heart attack or stroke is double in addition to their increased vulnerability to suffer from heart attack or stroke which is three times compared to people without the syndrome. Further, people with MetS have a fivefold greater risk of development of Type 2 Diabetes Mellitus (T2DM) [5].

The prevalence of MetS worldwide varies from less than 10% to 84%, depending upon the region, composition of the population studied with respect to age, sex, race, ethnicity etc. and the definition of the MetS used [6,7]. The prevalence of MetS (based on NCEP-ATP III criteria, 2001) varied from 8% to 43% in men and from 7% to 56% in women around the world [8].

In South Asia, particularly in India, high prevalence of MetS has been reported. In Chennai Urban Rural Epidemiology Study (CURES), MetS was identified in 23.2%

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subjects by WHO criteria, 18.3% by NCEP-ATPIII criteria, and 25.8% by IDF criteria [9]. In urban population, the prevalence of MetS ranged from 22.9 to 36.4% in males, and 39.9% to 46.4% in females using NCEP-ATP III criteria [10,11]. Insulin resistance being very common in adult Asian Indians may be responsible for the high prevalence of MetS in these populations [12,13]. Prevalence of MetS in Indians is expected to rise further with increasing urbanization, particularly with the adoption of modern lifestyles [9,14,15].

As a result of economic growth, urbanization and subsequent modernization, rural life style is changing drastically. The popular image of a farmer sweating day and night in his fields and leading a simple life is now fast changing into that of a modern day farmer well versed with the use of machines and modern amenities and, hence, much more prone to obesity and MetS. However since most of the studies have been carried out in urban areas, the data about the prevalence of MetS in rural areas remains inadequate and needs to be strengthened by further studies to help in framing of policies for its prevention. Therefore, the present study was planned to determine the prevalence, and predictors of MetS in a rural population of Haryana.

Objective

To determine the prevalence and predictors of MetS in a rural population of Haryana, India.

Methods

Study design and survey methods

This study was a community based cross sectional study and carried out in two districts, Jhajjar and Rohtak of Haryana state, India. A total of 80 child care centers (popularly known as, Anganwari centers; AWCs) were selected by simple random sampling - 40 from each district. Each AWC caters to a population of about 1000. Twenty-five subjects with age 20 years and above were selected from each AWC by random sampling. The study was conducted by house to house survey and out of the 2000 selected subjects, 300 were either not available in their homes on the interview day or did not turn up in the next morning at the nearest AWC to participate in the study (response rate 85 %). Thus 1700 subjects finally participated in the study. Pregnant women, severely ill individuals, and those who did not provide written consent, were excluded from the study.

Data collection

The socio-demographic data was collected using a pre-designed structured questionnaire including information about age, sex, education, occupation, socioeconomic status, physical activity, personal history of hypertension, type 2 diabetes, coronary artery disease, Cerebrovascular Accident (CVA) and dyslipidemia.

The subjects were advised to report after overnight fasting of at least eight hours at the nearest AWC. In the morning at the AWC, Blood Pressure (BP) was measured on the right arm in sitting position using standard mercury sphygmomanometer; minimum two readings were taken at an interval of at least five minutes and mean of the two readings was taken as the final BP. Waist Circumference (WC) was measured as the horizontal circumference between iliac crest and lower margin of rib cage with a non-stretchable measuring tape. Hip Circumference (HC) was horizontal circumference measured at the level of greater trochanter. Weight was measured to the nearest 0.1 kg and height to the nearest centimeter after removing the shoes. Body Mass Index (BMI), Waist-Hip Ratio (WHR) and Waist-Height Ratios (WHtR) were calculated. Fasting blood samples were collected and analyzed for plasma glucose and lipid profile.

Ethical clearance

The informed consent was obtained from each study subject. The information gathered from study subjects was kept confidential. Ethical clearance for the study was obtained from Institutional Ethics Committee of Pt B D Sharma Postgraduate Institute of Medical Sciences.

Definitions

Global Physical Activity Questionnaire (GPAQ) of the WHO was used to assess physical activity of participants [16]. The participants were categorized as hypertensive as per JNC VII guidelines (systolic BP ≥140 mmHg or diastolic BP ≥90 mmHg) [17,18].

Overweight and general obesity were defined according to World Health Organization (WHO) recommended cutoff points of body mass index (BMI) for Asian populations ie (≥23 kg/m^2 and ≥27.5 kg/m^2) [19]; whereas abdominal obesity or central obesity was measured using WC, WHR and WHtR. The WHR cutoff (>0.90 in case of males and >0.80 in case of females) was used as per the second report of National Cholesterol Education Program (ATP-2) [20]; whereas WHtR cutoff (≥ 5.2 in both males and females) was taken from one of our previous studies [21]. The WC cutoffs used in the study (males ≥ 90 cm and females ≥ 80 cm for south Asians) were as per the International Diabetes Federation (IDF) definition given below.

According to the new International Diabetes Federation (IDF) definition, MetS is defined as central obesity measured by ethnicity specific waist circumference (males ≥ 90 cm and females ≥ 80 cm for south Asians) plus any two of the following four factors [4]:

- Raised triglycerides: ≥ 150 mg/dL or specific treatment for this lipid abnormality.
- Reduced HDL cholesterol: < 40 mg/dL in males; < 50 mg/dL in females or specific treatment for this lipid abnormality.
- Raised blood pressure (BP): Systolic BP ≥ 130 mm Hg or diastolic BP ≥ 85 mm Hg or treatment of previously diagnosed hypertension.
- Raised fasting plasma glucose (FPG): ≥ 100 mg/dL, or previously diagnosed type 2 diabetes.

Data analysis

Data analysis was done using the Statistical Package for Social Sciences (SPSS) version 22. The level of significance was set at $p<0.05$. Student t-test for continuous variables and Chi-square test for categorical variables were used to determine the differences between study subjects with MetS and without MetS. Step-wise logistic regression was performed to identify predictors of MetS which was presented as adjusted Odds Ratio (OR) with 95% Confidence Interval (CI).

Results

Out of the total 1700 study subjects screened for the prevalence of metabolic syndrome (MetS), 818 (48.1%) were males and 882 (51.9%) were females. The prevalence of MetS was found to be 26.6% (95% CI: 24.6 - 28.8%) and it was higher in females (38.2%; 95% CI: 35.1-41.2%) compared to males (14.2%; 95% CI: 12.0-16.8%). Their baseline characteristics are shown in Table 1. Mean age was higher in subjects having MetS (both males and females; p<0.05 and <0.001 respectively). In both sexes, mean values of BMI, waist circumference, waist-hip ratio, waist-height ratio, total cholesterol, triglycerides, VLDL cholesterol and fasting plasma glucose were significantly higher in study subjects with MetS as compared to those without MetS (p<0.001). Low level of physical activity and high socioeconomic status had positive association with MetS; however, it was statistically significant only in females and males respectively.

Personal history of Hypertension (HTN), Type 2 Diabetes Mellitus (DM2), Cerebro-Vascular Accident (CVA) and Coronary Artery Disease (CAD) was positive in 31% (36/116) males and 18.4% (62/337) females in subjects with MetS compared to 13.1% (92/702) males and 6.6% (36/545) females in the category of subjects without MetS (p<0.001).

In our study, the prevalence of components of MetS in females and males was as follows: a). central obesity (increased WC), 51% and 19.3%; b). low HDL cholesterol, 88.7% and 32.3%; c). high triglycerides (TGs), 28.2% and 31.8%; d). raised blood pressure, 47.7% and 52.1%; and e). impaired FPG or diabetes, 42.4% and, 53.1%.

Hypertension was present in 60.3% and 51% of males and females respectively in the MetS category which were significantly higher as compared to 33.9% and 22.2% of their respective counterparts in the category without MetS (p<0.001).

We did logistic regression analysis to find out predictors of metabolic syndrome. Waist height ratio was found to be the strongest predictor of MetS with adjusted odds ratio (aOR) 32.4, followed by fasting plasma glucose (aOR, 4.5), triglyceride (aOR, 3.9) and hypertension (aOR 3.6). Females had three times more chances of developing MetS compared to males (aOR 3.1) whereas overweight and obese subjects had two to three times more chances of having MetS compared to subjects with normal BMI (Table 2).

Discussion

The prevalence of Metabolic Syndrome (MetS) is increasing exponentially in India, both in the urban and rural areas. It has escalated in different parts of India ranging from 11% to 41% [10,22]. The differences in the prevalence of MetS between various studies may be because of different criteria employed, different populations studied and different rates of prevalence of individual components of the MS. In the present study, the prevalence of MetS was 26.6% based on IDF criteria. Recent studies from rural areas of Goa and Andhra Pradesh also reported high prevalence of MetS using NCEP ATPIII criteria (36.9% and 30.2% respectively) [23,24]. The reasons could be that our study area falls in the national capital region of Delhi and there are no remote areas with lack of amenities of modern life. Further because of good connectivity many villagers commute to Delhi and other towns every day to earn livelihood. They, thus, enjoy a good exposure to the modern day living and are affected by all its vices like sedentary jobs, decreased physical activity, stress and high energy junk foods.

Table 1: Baseline characteristics of study population with MetS and without MetS, stratified by gender

		Male		Female	
		Without MetS (n=702)	With MetS (n=116)	Without MetS (n=545)	With MetS (n=337)
Age (years)		50.9 ± 16.8	53.3 ± 13.3[a]	44.0 ± 15.2	51.9 ± 13.1[b]
BMI(kg/m^2)		20.4 ± 3.3	23.9 ± 4.0[b]	21.1 ± 4.2	24.2 ± 4.6[b]
Waist (cm)		78.4 ± 9.4	88.6 ± 11.0[b]	75.8 ± 10.4	86.5 ± 11.6[b]
Waist hip ratio		0.89 ± 0.06	0.94 ± 0.07[b]	0.85 ± 0.07	0.91 ± 0.07[b]
Waist height ratio		0.46 ± 0.05	0.53 ± 0.07[b]	0.49 ± 0.07	0.56 ± 0.08[b]
Total cholesterol (mg %)		183.8 ± 38.3	186.7 ± 40.6	184.7 ± 40.2	196.3 ± 39.8[b]
Triglyceride (mg %)		114.3 ± 51.7	182.1 ± 79.5[b]	104.5 ± 38.8	159.0 ± 72.2[b]
HDL cholesterol (mg %)		41.7 ± 5.6	39.0 ± 5.2[b]	42.4 ± 6.5	42.0 ± 6.7
LDL cholesterol (mg %)		118.9 ± 31.9	110.7 ± 33.3[b]	121.2 ± 33.1	122.9 ± 33.4
VLDL cholesterol (mg %)		22.9 ± 10.3	36.4 ± 15.9[b]	21.0 ± 8.3	31.7 ± 14.3[b]
Fasting blood glucose (mg %)		106.1 ± 42.2	128.8 ± 51.2[b]	94.2 ± 23.3	119.2 ± 55.4[b]
Personal history of HTN/T2DM/CVA/CAD[c]	Yes	92 (71.9%)	36 (28.1%)[b]	36 (36.7%)	62 (63.3%)[b]
	No	610 (88.4%)	80 (11.6%)	509 (64.9%)	275 (35.1%)
Level of physical activity	Low	350 (85%)	62 (15%)	283 (55.1%)	231 (44.9%)[b]
	Moderate	300 (85.2%)	52 (14.8%)	249 (70.5%)	104 (29.5%)
	High	52 (96.3%)	2 (3.7%)	13 (86.7%)	2 (13.3%)
Hypertension	Yes	238 (77.3%)	70 (22.7%)[b]	121 (41.3%)	172 (58.7%)[b]
	No	464 (91%)	46 (9%)	424 (72%)	165 (28%)
Socio-economic Status	high & upper middle	364 (80.2%)	90 (19.8%)[b]	253 (59.7%)	171 (40.3%)
	lower middle & lower	338 (92.9%)	26 (7.1%)	292 (63.8%)	166 (32.2%)
Educational status	graduate and above	68 (79.1%)	18 (20.9%)	14 (63.6%)	8 (36.4%)
	below graduate	638 (86.7%)	98 (13.3%)[a]	531 (61.7%)	329 (38.3%)

[a]p <.05; [b]p <.001; [c]HTN: Hypertension; T2DM: Type 2 Diabetes Mellitus; CVA: Cerebrovascular Accident; CAD: Coronary Artery Disease

Table 2: Multivariate logistic regression to identify factors predicting MetS (N=1700)

Variable	OR (adjusted)	95% CI
Sex (female)	3.1	2.0 - 4.9
Hypertension (JNC VII)	3.6	2.5 - 5.2
Fasting plasma glucose (≥100 mg %)	4.5	3.1 - 6.5
Triglycerides (≥150 mg %)	3.9	2.7 - 5.7
HDL (< 40 mg% for males and < 50 mg% for females)	3.5	2.2 - 5.6
Waist height ratio (≥ 0.52)	32.4	20.0 - 52.4
Waist hip ratio (>0.90 for males/ >0.80 for females)	3.6	1.7 - 7.6
BMI (<23.0 kg/m^2) [Normal]	1.0	-
BMI (23.0 - 27.5 kg/m^2) [Overweight]	1.9	1.2 - 2.8
BMI (> 27.5 kg/m^2) [Obese]	2.9	1.7 - 4.8

*Odds ratio adjusted for Age, Socio-economic status and Physical activity

We also reported higher prevalence of MetS in females (38.2%) which was significantly higher than males (14.2%). One of reasons of high prevalence of MetS in females could be the popularity of high fat diets in postpartum females causing obesity in this segment of the population. It is evident from our study findings that the prevalence of MetS in females was significantly higher than that of males since earlier age groups (<30 years, 16.5% in females vs. 6.4% in males; 30-39 years, 23.3% vs. 10.5%; 40-49 years, 37.6% vs. 17.9% and so on; p <0.05). Majority of the other studies also found higher rates of MetS in females as compared to males [25-27]. In recent times, studies from different parts of India documented convincing findings of a higher prevalence of MetS in females compared to males (Das et al, 48.2% vs. 16.3%; Deedwania et al, 40.4% vs. 33.3% and Prasad et al, 42.3% vs. 24.9%) [28-30]. More stringent cut- offs employed in women for waist circumference and HDL, along with metabolic changes that accompany menopause could explain this high prevalence in females.

Significantly high prevalence of hypertension was found in the study subjects having MetS (60.3% in males and 51% in females) compared to those without MetS. On logistic regression analysis, hypertension had two and half to five times more chances of having MetS compared to those without hypertension.

Physical activity levels were found to be decreasing in rural population as our study revealed that 54.4% of total study subjects (926/1700) were having low physical activity score and out of these 31.6 % (293/926) were associated with MetS. In subjects having MetS, percentage of subjects with low physical activity was 64.6 % (53.4% in males and 68.5% in females). Prasad et al. also reported that 43% of the subjects with MetS in their study population were physically inactive [30].

Study population with MetS had statistically significant higher mean BMI as compared to those without MetS (Table 1). On logistic regression analysis, obese individuals were three times more likely to have MetS compared to those with normal BMI. Prasad et al also observed that obesity was a significant predictor of MetS in their study participants (aOR 5.058) [30].

Study subjects with MetS had low HDL cholesterol and high TGs levels compared to those without MetS (Table 1). On logistic regression analysis the subjects with low HDL/ high TGs levels were 3.5/ 4 times more likely to have MetS compared to those with normal HDL and TGs levels. In addition low HDL levels were much more prevalent in females (88.7%) compared to males (32.3%); and this gender bias in dyslipidemia is in coherence with dyslipidemia seen in females by Parikh et al. [31].

But a large number of studies clearly suggest that the degree of central fat distribution is more clearly related to metabolic risk as compared to BMI which is a measure of general obesity. Index of Central Obesity (ICO) defined by Parikh et al as a ratio of WC and height (WHtR) is a better parameter of central obesity as compared to WC and obviates the need for numerous cut offs for WC and provides a single cutoff value applicable to all races and both genders. It also identifies the central obesity in subjects with shorter height who had waist circumference smaller than the suggested cutoffs. Further it may also be applicable to children where existing parameters may not be useful. In one of the studies with a cutoff of 0.53, ICO fared better than WC in defining MetS by improving sensitivity although at the cost of slightly reduced specificity [32-35]. In our study also, the ICO ie WHtR (with a cut off of 0.52) emerged as the strongest predictor of MetS (aOR 32.4). Rajput et al also showed the ability of WHtR (ICO) to be used as a universal screening tool for the prediction of MetS in both urban and rural populations of Haryana irrespective of sex [21]. Studies from Japanese and Singaporean populations also supported the use of WHtR (ICO) as a better predictor of MetS and cardiovascular risk as compared to other anthropometric indices [36,37].

Conclusion

We conclude that there was a high prevalence of MetS in the studied rural areas of Haryana, India indicating a large proportion of population at risk for the development of T2DM and CVDs. Rural areas have traditionally been thought to be having low prevalence of T2DM and CVD but our study refutes this notion; and this will have wide ranging implications if extrapolated to other rural areas because a large percentage of population in India as well as many other developing countries lives in rural areas. Therefore our study should alert the health planners worldwide to come out with suitable preventive measures so as to prevent the impending epidemic of CVD and T2DM.

High ICO (WHtR), female sex, hypertension, raised plasma glucose, raised triglycerides, low HDL cholesterol, high waist-hip ratio, and obesity were found to be important predictors of MetS in our study.

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