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Research Article

INCIDENCE OF METABOLIC SYNDROME IN THE URBAN POPULATION OF INDORE, MADHYA PRADESH, INDIA

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ABSTRACT

Objective: This study determines the prevalence of metabolic syndrome (MS), with special reference to hyperglycemia and hyperlipidemia within urban population of a tertiary health-care hospital in Indore, Madhya Pradesh, India.

Methods: This cross-sectional study involved 726 subjects (467 men and 259 women). MS was defined using revised National Cholesterol Education Program (NCEP) criteria.

Results: When compared with the modified NCEP criteria, the prevalence of MS was found to be 7.51% (5.99% in men and 8.11% in women). Descriptive analysis exemplified a significantly increased mean values of fasting blood glucose ($p<0.01$), postprandial blood glucose ($p<0.01$), and lipid values ($p<0.05$) in the population. However, as compared to man, women showed significant elevated total cholesterol ($p<0.05$) and high-density lipoprotein ($p<0.01$). On the other hand, man exhibited increased triglycerides ($p<0.05$), cardiac risk ratio [C/H ($p<0.01$), and L/H ($p<0.01$)] than women. The highest prevalence of MS was seen in men of age group of 55-75 years and in women of age group of 20-34 years.

Conclusion: Our test population showed an increased rate of hyperglycemia and hyperlipidemia, with an increase in age, indicating a need to implement policies to control this abnormal MS.

Keywords: Cardiac risk ratio, Diabetes mellitus, Fasting blood sugar, Metabolic syndrome, Serum cholesterol.

INTRODUCTION

Metabolic syndrome (MS) is a complex web of abnormally altered metabolic factors that are associated with two-five times increased the risk of developing diabetes and/or cardiac problems [1,2]. A number of studies showed that the abnormal and uncontrolled serum glucose and lipid levels are important and amenable risk factors which have become major causes of morbidity and mortality in the world [3-5]. According to the World Health Organization, dyslipidemia is associated with 50% ischemic heart disease and more than 4 million deaths per year in the world [6]. In a parallel way, in Asian countries also a steady increase in these metabolic factors has been reported [6,7]. Although the mechanism of development and progression of MS is very complex, the possible main reasons of progressing MS appear to be changing lifestyle, increasing consumption of fat-rich diet, sedentary lifestyle, mental stress, aging and other environmental factors that play a central role in altered metabolism, insulin insensitivity, obesity, atherosclerosis, etc. [1,8] and leads to the disturbed normal physiochemical processes [4,9,10].

Indeed, India already has 50 million diabetic patients [11], and the incidences of adult cardiac problems have also been increased to 8-10% in urban areas [12]. This is partly elucidated by their diabetes-susceptible genetic factors [1,9]. However, genetic factor alone cannot explain the rapid boost in these disorders. Certainly above-mentioned factors also play a significant role and their cumulative effects negatively influence the normal metabolism [4,10]. Although with especial reference to blood glucose and different lipid parameters several studies have been conducted, which helped to extract out comparative epidemiological data of different Indian populations [5,7,13,14], these are contradictory to each other. For example in National Urban Diabetes Study study, the prevalence of diabetes was found to be higher in south Indian cities than northern cities [15].

Some more reports of blood glucose and lipid profiles of population from different eastern, western, northern and southern India showed the growing incidences of irregularities in serum glucose and total cholesterol (TCHO), high-density lipoprotein (HDL), low-density lipoprotein (LDL), and cardiac risk ratio (CRR) as well [4,13,16,17]. Some data were also documented in different age, sex, and diet groups of Indian populations [4,18,19]. However, the prevalence of these metabolic abnormalities and their sex and age specific distinction in a region of central India has not been studied till now. Because extensively different prevalence rates have been observed with the same parameters in different regions of India, much more studies are needed in different subtypes of populations so that overall health status, as well as risk factors, can be quantified. With these concepts, this study was aimed to evaluate the prevalence of metabolic disorders with special reference to blood glucose and lipid profile parameters of sample population of Indore.

METHODS

The study population consisted of subjects who had attended the general health checkup program at executive health scheme department, Bombay hospital, Indore, India, totaling 726 subjects of both sex (467 men and 259 women). Individuals of both sexes were further classified into three different age groups. Groups 1, 2 and 3 have subjects of age 20-39, 40-54 and 55-80 years, respectively. In the health checkup department, patient's physical and medical history was taken, and a copy of each report was maintained in the medical records department. The medical record folders of all these subjects were screened manually.

Here, only blood glucose and lipid profile data have been analyzed. All the subjects were fasted overnight and the blood samples collected in plain vacutainer tubes. All the tests were done using an automated analyzer (Xp and analyzer) based on Beer-Lambert's law. Fasting blood glucose (FBS), postprandial blood glucose (PPBS), TCHO, HDL, and triglycerides (TGL) were estimated directly by autoanalyzer. While, LDL, very LDL (VLDL), C/H and L/H ratios were calculated out using

standard formulas [20,21]. Before analysis, the analyzer was calibrated with calibrators provided by the manufacturer. Controls were run at both normal and pathological concentrations for each analyte. During the course of the study, there was no change in the equipment, reagents, calibration standards, and controls.

The overall analysis was done at two stages. (1) The data were compared with normal reference values of National Cholesterol Education Program (NCEP) to determine the number and percentage of population falling in normal, borderline and diseased/risk range of these metabolic factors, which could give superficial idea about general health status of population, (2) descriptive and relative statistical analyses were carried out in whole, male and female individuals, which helped to provide a detailed report about the sample population. The data are expressed as the means±standard error (SE). Differences in mean values were compared using Prism Software, Version 5.1 for Windows, Inc., La Jolla, CA, USA by one-way analysis of variance (ANOVA) followed by Student's t-test. The $p<0.05$ was considered as statistically significant.

RESULTS

The incidence of MS was observed to be 7.51% (5.99% men and 8.11% women) than NCEP criteria (Tables 1 and 2). For values of FBS and PPBS, 5.11% and 13.92% individuals showed borderline hyperglycemia, while 18.92% and 17.47% individuals were found to be hyperglycemic, respectively. In the case of TCHO, LDL, HDL and TGL also, only 66.52%, 36.91%, 81.63% and 68.32% population exhibited normal range; while a considerably decreased number of people showed normal values of C/H and L/H (28.73% and 13.39%, respectively). Although no significant difference was observed in FBS and PPBS of male and female individuals, in case of lipid parameters women population showed a significantly ($p<0.01$) increased risk of hypercholesterolemia (11.19%) than men (6.85%), but due to comparatively higher value of HDL they showed lower C/H and L/H ratio than men. The prevalence of hypertriglyceridemia was more among men (29.18%) than in women (20.15%). In general, the prevalence of borderline hyperglycemia, hypercholesterolemia, and hypertriglyceridemia was higher in studied population ($p<0.001$, $p<0.001$, and $p<0.01$, respectively). The higher percent of individuals had a greater risk of cardiac problems as indicated by higher C/H and L/H ratio (38.26% and 25.96%) among all subjects. Of course, in the same variables men showed significantly ($p<0.01$) higher risk (44.94% and 29.24%) than women (26.74% and 19.37%).

In descriptive statistical analysis, a great difference was found in minimum and maximum values of different variables. Higher levels of 25, 50 (median) and 75 percentiles have been noticed in all, male and female populations (Table 3). In one-way ANOVA, a significant difference was found in TC ($p<0.05$), HDL ($p<0.0001$), VLDL and CRR ($p<0.001$ for both), and TGL ($p<0.01$). In Student's t-test, no significant difference was found in the mean values of FBS and PPBS across two sexes. However, the TCHO and HDL levels were significantly high ($p<0.05$ and $p<0.0001$, respectively) in women than in men, whereas reverse observations were made in case of C/H ($p<0.0001$), L/H ($p<0.001$), and TGL ($p<0.01$) in the same populations. A narrow range of confidence interval and coefficient of variations indicates that our data are consistent with a Gaussian distribution.

DISCUSSION

The present analysis revealed that a higher number of individuals showed higher values of blood glucose and different lipid parameters, but these were not consistent in all three tested parameters that resulted in comparatively less prevalence of metabolic abnormalities in general population of Indore. However, the percent and extent of abnormality in different parameters were different in individuals of different sex and age groups. Since no earlier study has been documented in this central Indian population, these results can be compared with other studies conducted in different regions of India. Earlier studies demonstrated a much higher prevalence of MS in urban population of Jaipur (22-25.1%) [4], in urban city dwellers in Odisha (24.9% and 42.3%) [10], in Warangal region of Andhra Pradesh (54.8% and 45.2%) [22], and in Gwalior-Chambal region of Central India (45.8%) [5]. However, the increased values of FBS and PPBS in studied population corroborate with the results of Gupta *et al*. [4] where 15.5% male and 10.8% female population were found to be diabetic, respectively. Moreover, recently in different studies a higher incidence of diabetes was reported from Delhi (15%), Jaipur (20.1%), Channai (15.5%), and Kochi (19.5%) [4,23]. Epidemiological studies from Kerala, Mumbai, Kolkata, Hyderabad, Guwahati, etc. also indicated a higher prevalence of hyperglycemia in common people [24,25]. The occurrence of hypercholesterolemia and hypertriglyceridemia was also found to be more in the sample population. These data were also consistent with the analysis of Durgawale *et al*. [17] and Sanyal *et al*. [26]. An increased mean values of TCHO, LDL, TGL, C/H and L/H with a significant difference was found in different subgroups of male and female populations, indicating different degrees of risk for cardiovascular disease (CVD) in them [13,17,25].

Table 1: Characteristics reference values of different parameters (values are in mg/dl)

Group	FBS	PPBS	TCHO	HDL	LDL	VLDL	C/H	L/H	TGL
Normal	<110	<140	<200	>40	<100	2-30	<3.4	<1.5	<150
Border line	111-120	141-180	201-240	30-40	100-160	31-40	3.4-4.5	1.5-3.2	150-200
Risk	>120	<180	>240	<30	>160	>40	>4.5	>3.2	>200

The ranges of different parameters are as per NCEP [6]. FBS: Fasting blood glucose, PPBS: Postprandial blood glucose; TCHO: Total cholesterol, HDL: High density lipoprotein, LDL: Low density lipoprotein, VLDL: Very low density lipoprotein, C/H: Ratio of TCHO and HDL, L/H: Ratio of LDL and HDL, TGL: Triglyceride

Table 2: Clinical characteristic of the sample population lies

Groups total	Population type	FBS	PPBS	TCHO	HDL	LDL	VLDL	C/H	L/H	TGL
In normal range	All	75.96	68.61	66.52	81.63	36.91	68.32	28.73	13.39	68.32
	Male	75.27	68.42	69.16	75.11	36.83	66.16	22.53	10.94	66.16
	Female	77.22	68.95	61.77	93.41	37.06	72.20	39.92	17.83	72.20
At border line	All	5.11	13.92	25.06	10.49	55.09	17.08	33.42	60.63	17.08
	Male	5.37	15.13	23.98	14.59	55.88	16.06	33.26	59.87	16.06
	Female	4.63	11.69	27.03	3.10	53.66	18.92	33.72	62.01	18.92
At risk/diseased	All	18.92	17.47	8.40	7.87	7.98	14.60	37.84	25.96	14.60
	Male	19.35	16.44	6.85	10.30	7.28	17.77	44.21	29.18	17.77
	Female	18.14	19.35	11.19	3.48	9.26	8.88	26.35	20.15	8.88

Data expressing % of individuals as compare to reference values of given parameters in all, male and female population. FBS: Fasting blood glucose, PPBS: Postprandial blood glucose; TCHO: Total cholesterol, HDL: High density lipoprotein, LDL: Low density lipoprotein, VLDL: Very low density lipoprotein, C/H: Ratio of TCHO and HDL, L/H: Ratio of LDL and HDL, TGL: Triglyceride

Table 3: Descriptive statistics of serum parameters of all sample population, males and female

Variables	Gender	FBS	PPBS	TCHO	HDL	LDL	VLDL	C/H	L/H	TGL
Min/Max	Male	56/342	65.5/573	69/363	12/127	25.6/239	7.6/265.6	1.54/12.08	0.382/7.91	38/1328
	Female	30/400	57.8/569.6	109/287	17/177	34.0/214	5/114.4	1.29/12.3	0.225/5.70	25/572
25 per	Male	89	98	159	36	87.2	17.6	3.51	1.97	88
50 per		97	116	182	42	111.8	24.2	4.31	2.62	123
75 per		110	154.5	207	49	133.2	35	5.2	3.36	177
	Female	88	98	162	42	88.8	15.6	3.06	1.71	78
		95	117	189	49	114.1	22.2	3.7	2.26	111
		109	151.7	214	58	136.2	31.2	4.62	2.97	156
Mean±SEM	Male	108.7±1.77	140.3±3.38	183.3±1.84	43.38±0.58^{c}	111.2±1.6	28.74±0.85	4.49±0.06^{a}	2.74±0.05	148.0±4.92
	Female	108.2±2.55	144.1±4.81	190.2±2.33^{a}	51.67±1.04$^{c, z}$	114.1±2.05	24.69±0.87$^{a, y}$	3.97±0.08$^{b, z}$	2.41±0.06$^{b, z}$	123.4±4.35$^{a, z}$
95% CI	Male	105.2-112.2	133.6-146.9	179.7-186.9	42.24-44.53	108.1-114.4	27.06-30.43	4.36-4.62	2.64-2.84	138.4-157.7
	Female	103.2-113.2	134.6-153.5	185.6-194.8	49.61-53.74	110.1-118.1	22.97-26.4	3.8-4.14	2.29-2.52	114.9-132
CV (%)	Male	35.19	51.55	21.68	29.08	31.07	64.42	32.26	40.19	71.91
	Female	37.94	52.54	19.75	32.58	28.89	56.73	35.39	41.73	56.73

Min: Minimum value, Max: Maximum value; 25, 50, 75 per: Pertile values at 25%, 50%, 75% level, Mean±SEM: Mean±standard error of mean, CI: Lower to upper confidence interval of mean, CV: Coefficient of variation. ^{a}p<0.05, ^{b}p<0.01 and ^{c}p<0.001 as compare to all sample population, ^{y}p<0.01 and ^{z}p<0.001 as compare to male, FBS: Fasting blood glucose, PPBS: Postprandial blood glucose; TCHO: Total cholesterol, HDL: High density lipoprotein, LDL: Low density lipoprotein, VLDL: Very low density lipoprotein, C/H: Ratio of TCHO and HDL, L/H: Ratio of LDL and HDL, TGL: Triglyceride

In our analysis, as compared to males, female population showed decreased level of serum TGL and VLDL, as also found in Maharastrian and Bengali (Kolkata) population [25]. According to a study of Jhala *et al*. [16], the values of TCHO, TGL, LDL, and VLDL were found to be increased with age as also observed in our population. These abnormal metabolic factors were also reported to be positively correlated with increased rates of non-alcoholic fatty liver disease in obese patients [27]. On the other hand, enhanced values of C/H and L/H indicated an increased possibility of CVD and ischemic heart disease [28] was prominent in males [25].

Collectively various factors determine the progress of these metabolic complications including increasing consumption of sweetened beverages and high-fat diet that may result in abnormally high serum lipid level, overproduction or lack of clearance of these lipoprotein particles, or due to other defects in the apolipoproteins or metabolic enzyme deficiencies leading to dyslipidemia [2,29,30]. Furthermore, the increased serum levels of TG and LDL have been found to be associated with increased plasma TNFα and altered levels of adiponectin, resistin, leptin, and plasminogen activator inhibitor 1 that may lead to insulin resistance by enhancing the production of inflammatory cytokines [9,19]. In addition, elevated serum TC and TG are also found to induce pancreatitis [31,32] resulting in diabetes.

Thus, the increased prevalence of these MS among common people appear to be responsible for progressing diabetes, CVD, hypertension, and coronary artery diseases [17,25]. It has also been realized that the number of adults with diabetes and CVDs in the world is increasing rapidly [30]. Unfortunately, in this study also men and women of 35-54 years age group showed significantly increased values of FBS, PPBS, TCHO, LDL and TGL than reference values.

Our data favored the prediction of Sawant *et al*. [3], who estimated that the CVD will be the major cause of disability and death in India. These data suggest a strong need for awareness programs for prevention and control of MS [7,18]. There is a need of bringing about dietary changes and identifying individuals at high risk of these MS and then taking intensive intervention efforts [2,11,23,33,34]. These attempts can serve as effective ways to reduce/prevent the incidence of MS and the ever increasing burden of diabetes and CVD in general population.

CONCLUSION

In conclusion, this study revealed that the prevalence of MS is comparatively less in studied populations, but a greater number of individuals have hyperglycemia, hyperlipidemia and increased values of cardiac risk factors, indicated that the individuals have a higher possibility of cardiac problems. In addition to this, these abnormalities were also found to worsen with age. Although this study was conducted involving a limited number of human samples, this appears to be the first report demonstrating statistically significant alterations in public health status. This is further suggested that the people should be made aware to improve their routine life.

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