A STUDY ON PREVALENCE OF METABOLIC SYNDROME AND ASSOCIATED CARDIOVASCULAR RISK FACTORS AMONG DIABETIC PATIENTS ATTENDING A TERTIARY CARE HOSPITAL IN EASTERN ODISHA

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ABSTRACT

BACKGROUND
Diabetes, particularly Type 2 greatly increases the risk of heart disease and stroke. Other conditions like high blood pressure, family history, obesity, alcohol, smoking & tobacco consumption contribute to the risk for developing cardiovascular disease.

MATERIALS AND METHODS
The study was conducted on 608 subjects in Medicine Department of KIMS, Bhubaneswar. Coronary artery disease (CAD) was diagnosed based on a combination of previous medical history, clinical findings and electrocardiogram (ECG) changes. Details of diabetes, hypertension, hypercholesterolemia, low high-density lipoprotein (HDL) cholesterol, hypertriglyceridemia and obesity/alcohol/tobacco/education status/occupation data were also documented. Objectives: The aim of the study was to determine the prevalence of Metabolic Syndrome (MetS) and associated cardiovascular risk factors among diabetics in an urban population attending a tertiary care hospital in Eastern Odisha.

RESULTS
The prevalence of different components of metabolic syndromes in diabetic and non-diabetic was as follows: (a). Dyslipidaemia (in diabetics 85.6% vs. in non-diabetics 78.3%), (b). Hypertension (in diabetics 73.3% vs. in non-diabetics 34.2%), (c). Obesity (≥90 cm in females/≥ 100 cm in males) (in diabetics 18.7% vs in non-diabetics 8.9%), (d). Raised fasting blood sugar (FBS) (in diabetic group 94.1% vs. in non-diabetic group 7.11%), (e). Raised systolic blood pressure (SBP) (in diabetic group 62.2% vs. in non-diabetic group 58.8%) and (f). Raised diastolic blood pressure(DBP) (in diabetics group 56.8% vs. in non-diabetics 44.2%).

CONCLUSION
This study has shown an increased prevalence of Metabolic Syndrome (49.5%), and through logistic regression analysis, has delineated the key risk factors driving morbidity. Most of the individual risk factors were more prevalent in women, compared to men; women were more likely to have Metabolic Syndrome. The most prevalent component was hypertension, followed by central obesity, low HDL-C and hypertriglyceridemia. Low educational status and obesity also have greater predictive effects on Metabolic Syndrome in type 2 diabetics.

KEYWORDS
Diabetes, Cardiovascular, Hypertension, Metabolic Syndrome, Hypercholesterolemia.

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BACKGROUND
Diabetes mellitus is a group of metabolic illness in which elevated blood sugar remains over a prolonged period of time unless detected earlier leading to morbidity and mortality. The most common clinical features include polyphasia, polydipsia and polyuria in presence of raised blood or plasma sugar. If left untreated, diabetes can lead to many complications which include acute complications like diabetic ketoacidosis and hyperosmolar hyperglycaemic state and chronic macro and micro vascular complications

like cardiovascular disorder, stroke, chronic kidney disease, foot ulcers, and damage to the eyes.[1,2,3,4,5,6]

People with diabetes develop atherosclerosis at a younger age and more severely than people without diabetes. People with diabetes may have a silent myocardial ischaemia (SMI) because of involvement of myocardial blood vessels and autonomic neurons. Premenopausal women who have diabetes have an increased risk of heart disease because diabetes cancels out the protective effects of oestrogen.[7,8,9]

Individuals with diabetes most often die of cardiovascular disease (CVD) rather than from a cause uniquely related to diabetes, such as ketoacidosis or hypoglycaemia. Diabetic patients have a two to six-fold higher incidence of cardiovascular disease than non-diabetic population. Furthermore, diabetic patients with CVD sustain a worse prognosis for survival than CVD patients without diabetes and their quality of life also depreciates. Therefore, diabetes has been considered as a risk equivalent to a non-diabetic patient with preexisting heart disease. Identification of patients at risk for CVD could facilitate the prevention or retardation of cardiovascular events.[10,11,12]

Statistics speaks loud and clear that there is a strong correlation between cardiovascular disease (CVD) and diabetes. At least 68 percent of people aged 65 or older with diabetes die from some form of heart disease; and 16% die of stroke. Adults with diabetes are two to four times more likely to die from heart disease than adults without diabetes. The American Heart Association considers diabetes to be one of the seven major controllable risk factors for cardiovascular disease.[13,14,15]

In India, a high prevalence of metabolic cardiovascular risk factors has been reported among clinic-based patients with diabetes. Only a few population-based studies in India have determined the prevalence of various cardiovascular risk factors in patients with diabetes. The aim of the study was to examine the cardiovascular risk in patients suffering with diabetes and to determine the prevalence of metabolic syndrome and their associated factors. This study was aimed to evaluate the prevalence of metabolic syndrome in an urban population, relating it to demographic, and biochemical parameters and comparing it to national and international studies.[16,17,18,19]

MATERIALS AND METHODS

This cross-sectional study was performed on 608 patients, both diabetic and non-diabetic (mean age 50.23 ± 9.155 years) attending Medicine Department of KIMS, Bhubaneswar, during a 10-month period from July 2016 to April 2017.

CVD was diagnosed based on a combination of previous medical history, clinical findings (e.g., Dyslipidemia, Hypertension, Smoking, and Obesity), electrocardiogram (ECG) changes, and Echocardiographic study.[17]

The patients with chronic heart failure, myocardial infarction or unstable angina pectoris and acute coronary syndrome (ACS) who needed emergent coronary intervention or surgery, hepatic and kidney diseases, hyperthyroidism, pregnancy, and patients with ejection fraction (EF) < 60% were excluded from the study.

All patients gave informed consent, and ethical approval was obtained from Institutional Ethics Committee. The demographic data including age, sex, physical activity and previous medical history and treatment were recorded at the first meeting with the patients. The age was categorized as <50 and >50 years old. Physical activity was classified into two categories: (a). no exercise and sedentary work and (b). regular exercise or strenuous work.[18]

The weight and height of the patients were recorded with light clothes. Body mass index (BMI) was defined as body mass in kilograms divided by the square of the body height in meters (expressed in units of kg/m^2).

BP was measured in the seated position after at least 5 minutes of rest with empty bladder. The measurement was performed on the right arm using a mercury manometer. Two recordings were carried out, and the average of the two recordings was used for analysis.

The blood samples were obtained after overnight fasting. Serum levels of total cholesterol, high-density lipoprotein-cholesterol (HDL), low-density lipoprotein-cholesterol (LDL), triglycerides and fasting blood glucose (FBG) were assayed by enzymatic procedures using an auto-analyzer.

In this study, metabolic syndrome was described according to the modified protocol of Adult Treatment Panel. According to the modified NCEP criteria, the presence of any three of the following five factors mentioned in the table was required for a diagnosis of Metabolic Syndrome. The modified NCEP ATP III criteria suggested the cut-off points of waist circumference should be ethnic specific where individuals of Asian origin should use the cut-off of 90 cm in men and 80 cm in women. For NCEP criteria, abdominal obesity is a component of the syndrome but not a prerequisite for its diagnosis.[12]

Measure (Any 3 of 5 Constitute Diagnosis of Metabolic Syndrome)	**Categorical Cut Points**
Elevated waist circumference*†	≥102 cm (≥40 inches) in men
	≥88 cm (≥35 inches) in women
Elevated triglycerides	≥150 mg/dL (1.7 mmol/L)
	Or
	On drug treatment for elevated triglycerides‡
Reduced HDL-C	<40 mg/dL (1.03 mmol/L) in men
	<50 mg/dL (1.3 mmol/L) in women
	Or
	On drug treatment for reduced HDL-C‡
Elevated blood pressure	≥130 mm Hg systolic blood pressure
	Or
	≥85 mm Hg diastolic blood pressure
	Or

	On antihypertensive drug treatment in a patient with a history of hypertension
Elevated fasting glucose	≥100 mg/dL
	Or
	On drug treatment for elevated glucose

Criteria for Clinical Diagnosis of Metabolic Syndrome

*To measure waist circumference, locate top of right iliac crest. Place a measuring tape in a horizontal plane around abdomen at level of iliac crest. Before reading tape measure, ensure that tape is snug but does not compress the skin and is parallel to floor. Measurement is made at the end of a normal expiration.

†Some US adults of non-Asian origin (e.g.- white, black, Hispanic) with marginally increased waist circumference (e.g.- 94-101 cm [37-39 inches] in men and 80–87 cm [31-34 inches] in women) may have strong genetic contribution to insulin resistance and should benefit from changes in lifestyle habits, similar to men with categorical increases in waist circumference. Lower waist circumference cutpoint (e.g.- ≥90 cm [35 inches] in men and ≥80 cm [31 inches] in women) appears to be appropriate for Asian Americans.

‡Fibrates and nicotinic acid are the most commonly used drugs for elevated TG and reduced HDL-C. Patients taking one of these drugs are presumed to have high TG and low HDL.

Statistical Analyses

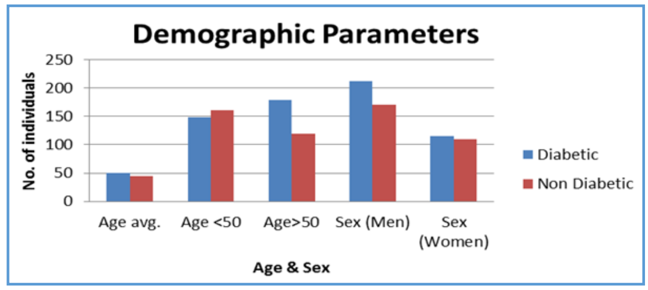
Statistical analyses were performed using Statistical Package for the Social Sciences version 21 (SPSS Inc., Chicago, IL, USA). Data were presented as mean ± standard deviation (SD), frequencies and percentages. Chi-square and Student's t-test were used for statistical analysis. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for Metabolic Syndrome and individual components of it. Multivariable linear regression model, adjusted for sex, was used to evaluate the association between variables. $P < 0.05$ was considered significant.

RESULTS

The demographic and clinical characteristics of the 608 Patients with and without diabetes are presented in Table 1. Of these, 49.5% had Metabolic Syndrome, and it was 55.9% among women and 40.2% among men ($P < 0.05$). The highest prevalence was present in patients aged more than 50 years (87%, $P < 0.05$).

Groups	Diabetic (327), n (%)	Non-Diabetic (281), n (%)	P
Age (Avg. ± SD)	50.23 ± 9.155	44.94 ± 10.733	
Age (yrs.), n (%)			
<50 years	148 (45.2)	161 (57.29)	0.152
>50 years	179 (54.74)	120 (42.70)	0.356
Sex, n (%)			
Men	212 (64.8)	171 (60.9)	0.3112
Women	115 (35.2)	110 (39.1)	0.351

Table 1. Demographic Characteristics of Patients

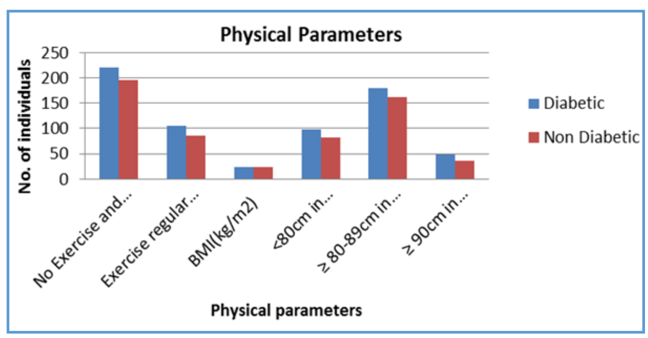


Graph 1. Demographic Characteristics of Individuals

The mean WC, BMI and the prevalence of high waist circumference obesity was high among the study sample. Table 2 explains the physical characteristics of the study population.

Groups	Diabetic (327), n (%)	Non-Diabetic (281), n (%)	P
Physical Activity			
No Exercise and sedentary work	221 (68.0)	196 (69.7)	0.5705
Exercise regular or strenuous work	106 (32.0)	85 (30.2)	0.0653
BMI (kg/m2)	24.42 ± 3.719	23.95 ± 2.412	
WC (cm)			
<80 cm in females / <90 cm in males	99 (30.27)	82 (29.18)	0.235
≥ 80-89 cm in females / ≥ 90-99 cm in males	179 (55.2)	162 (57.65)	0.412
≥ 90 cm in females / ≥ 100 cm in males	49 (15.1)	37 (13.16)	0.621

Table 2. Physical Characteristics of Individuals



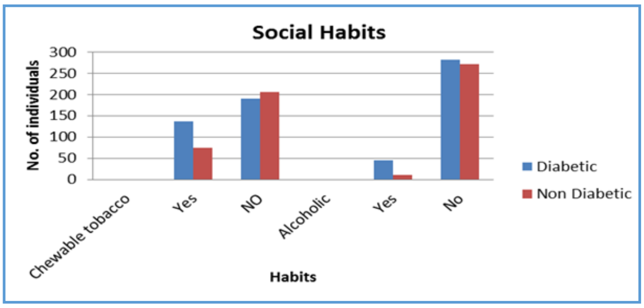
Graph 2. Physical Parameters of Individuals

Out of the 327 Diabetic patients, 137 were chewing tobacco and 45 were alcoholic and out of 281 non-diabetes, 75 were chewing tobacco and 10 were alcoholic. (Table 3)

Groups	Diabetic (327), n (%)	Non-Diabetic (281), n (%)	P
Chewable Tobacco			
Yes	137 (41.9)	75 (26.5)	0.963
No	190 (58.1)	206 (73.5)	0.542

Alcoholic			
Yes	45 (13.8)	10 (3.6)	<0.0001
No	282 (86.2)	271 (96.4)	0.123

Table 3. Social Habits of Individuals

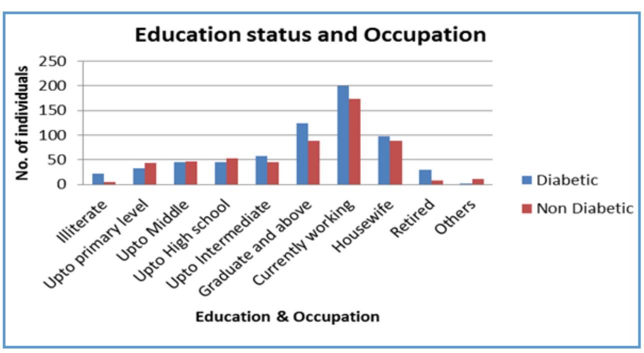


Graph 3. Social habits of individuals

The educational status and occupation of 608 patients are presented in Table 4. Among diabetics 22 were illiterate whereas 124 were graduate or above and 199 number of diabetics were currently working in comparison to non-diabetics where 5 were illiterate, 89 were graduate or above and 173 were currently working.

Groups	Diabetic (327), n (%)	Non-Diabetic (281), n (%)	P
Education Status			
Illiterate	22 (6.8)	5 (1.8)	0.562
Up to primary level	33 (10.2)	44 (15.8)	0.236
Up to Middle	45 (13.8)	46 (16.1)	0.546
Up to High school	45 (13.8)	52 (18.6)	0.312
Up to Intermediate	58 (17.8)	45 (15.8)	0.856
Graduate and above	124 (37.5)	89 (31.9)	0.452
Occupation			
Currently working	199 (61.2)	173 (63.1)	0.123
Housewife	97 (29.8)	89 (31.8)	0.562
Retired	29 (8.7)	8 (2.9)	0.554
Others	2 (0.6)	11 (3.91)	0.963

Table 4. Education Status & Occupation of Individuals

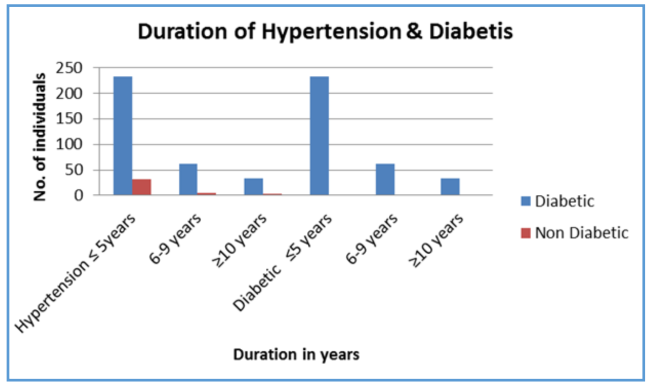


Graph 4. Education Status & Occupation of Individuals

Among the individuals, more number of subjects (232) were suffering from diabetes and hypertension which was of less than 5 years duration. (Table 5)

Parameters	Diabetic	Non-Diabetic	P
Diabetes Duration			
≤5 years	232 (71.1)	NA	-
6-9 years	62 (18.8)	NA	
≥10 years	33 (10.1)	NA	
Duration of Hypertension			
≤5 years	232 (71.1)	32 (78.0)	0.231
6-9 years	61 (18.7)	5 (34.2)	0.521
≥10 years	34 (10.2)	4 (28.5)	0.291

Table 5. Duration of Diabetes & Hypertension in Participants

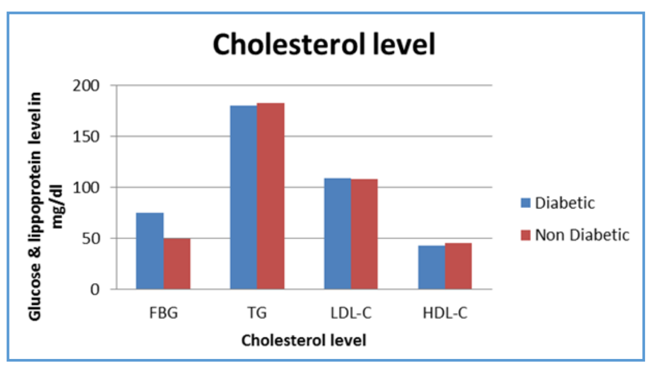


Graph 5. Duration of Diabetes & Hypertension in Participants

The serum levels of FBG, cholesterol, TG and LDL-C in diabetic patients with Metabolic Syndrome were significantly higher, and HDL levels were significantly lower than in those without Metabolic Syndrome as shown in Table-6.

Parameters	Diabetic (Avg. ± SD)	Non-Diabetic (Avg. ± SD)
FBG (mg/dl)	74.88 ± 68.294	49.180 ± 13.665
Cholesterol (mg/dl)		
TG (mg/dL)	179.91 ± 45.993	182.98 ± 38.065
LDL-C (mg/dL)	108.64 ± 35.168	108.568 ± 27.52
HDL-C (mg/dL)	42.90 ± 11.490	45.502 ± 8.37

Table 6. Status of Blood Glucose & Cholesterol Level in Participants

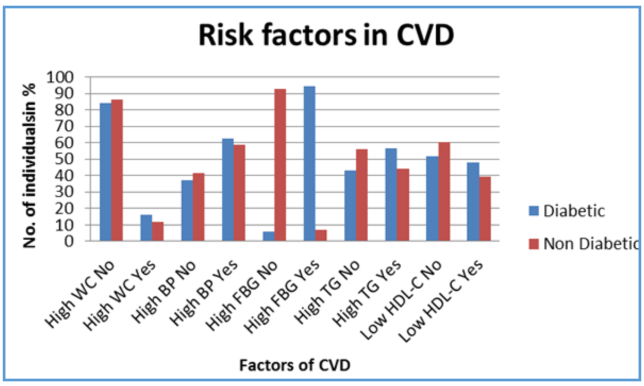


Graph 6. Status of Blood Glucose & Cholesterol Level in Participants

As shown in Table 7, low HDL (157 diabetic vs 111 non-diabetic, P, 0.019), high FBG (308 diabetic vs 20 non-diabetic, P, 0.659), were the most prevalent risk factors in patients with diabetes as compared to those without diabetes.

Parameters	Diabetic	Non-Diabetic	P
High WC, n (%)			
No	275(84.09)	242(86.12)	0.001
Yes	52(15.91)	39(13.88)	
High BP, n (%)			
No	122(37.3)	116(41.2)	0.48
Yes	205(62.2)	165(58.8)	
High FBG, n (%)			
No	19(5.81)	261(92.8)	0.659
Yes	308(94.1)	20(7.11)	
High TG, n (%)			
No	141(43.11)	157(55.8)	0.011
Yes	186(56.88)	124(44.2)	
Low HDL-C, n (%)			
No	170(51.9)	170(60.49)	0.019
Yes	157(48.1)	111(39.5)	

Table 7. Prevalence of Individual Components of risk of CVD in Diabetic Patients

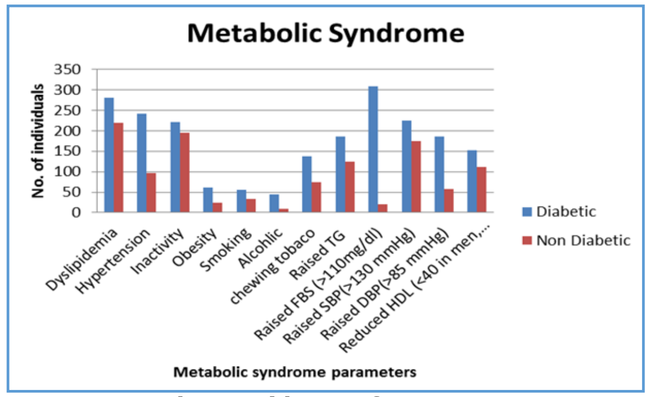


Graph 7. Prevalence of Individual Risk of CVD

The incidence of components of metabolic syndromes like dyslipidemia (85.6% diabetic vs 78.3% non-diabetic), hypertension (73.3% diabetic vs 34.2% non-diabetic) and obesity (≥ 90 cm in females/ ≥ 100 cm in males) (18.7% diabetic vs 8.9% non-diabetic) are presented in Table 8.

Metabolic syndrome	Diabetic	Non-Diabetic	P
Dyslipidaemia	280 (85.6)	220 (78.3)	-
Hypertension	241 (73.3)	96 (34.2)	-
Inactivity	221 (67.6)	196 (69.9)	-
Obesity	61 (18.7)	25 (8.9)	-
Smoking	56 (17.1)	34 (12.1)	-
Alcoholic	45 (13.8)	10 (3.6)	-
Chewing tobacco	137 (41.9)	75 (26.5)	-
Raised TG (≥150 mg/dL)	186 (56.88)	124 (44.2)	0.011
Raised FBS (≥100 mg/dl)	308 (94.1)	20 (7.11)	0.659
Raised SBP (≥130 mmHg)	205 (62.2)	165 (58.8)	0.401
Raised DBP (≥85 mmHg)	186 (56.88)	124 (44.2)	0.418
Reduced HDL (<40 mg/dL in men, <50 mg/dL female)	157 (48.1)	111 (39.5)	0.019

Table 8. Incidence of Components of Metabolic Syndrome in Diabetic and Non- Diabetic Population



Graph 8. Incidence of Components of Metabolic Syndrome

DISCUSSION

This study analyzes the prevalence of metabolic syndrome in diabetic & non-diabetic in a large, representative sample of the urban eastern India population average of 50 years old. In general, epidemiologic studies have found higher prevalence rates of metabolic syndrome in diabetic population than in non-diabetic ones. The prevalence of metabolic syndrome was also more in individuals with obesity, habits of tobacco and alcohol & diabetes with hypertension. In a study Franco *et al.* found a high prevalence of MetS among patients with high blood pressure living in Cuiabá, with a significant association with BMI >25 kg/m^2, insulin resistance (HOMA index) and, especially, a family history of high blood pressure.[19] According to a study conducted by Gisela Cipullo Moreira et al. the prevalence of MetS is similar to that of developed countries: it increases with age, shows no significant differences between sex and among social classes. However, lower levels of education are associated with higher prevalence of MetS. Metabolic syndrome is more prevalent in individuals with higher BMI (especially obese) and inactive or minimally active. There was a higher prevalence of high waist circumference in women, and high TG in men. Individuals aged ≥40 years with MetS have a higher prevalence of cardiovascular complications.[20]

A study by Kokubo et al. reviews the associations of impaired glucose metabolism and dyslipidemia with CVD in Japanese cohort studies. Diabetes mellitus is a risk factor for coronary heart disease and ischemic stroke. Impaired fasting glucose and high-normal blood pressure were shown to be independent risk factors for CVD and coronary heart disease in an urban cohort. The combination of these two borderline categories may increase the risk for CVD. Impaired glucose tolerance has not been observed as a risk factor for the incidence of CVD in Japan. The Japanese evidence for the positive association of total cholesterol with coronary heart disease is similar to that of previous Western studies. Associations with all-cause mortality were observed for both the lower and higher levels of cholesterol: Higher levels of LDL cholesterol have been shown to increase the risk of coronary heart disease and atherothrombotic infarction, whereas lower levels of LDL cholesterol may increase the risk of intracerebral hemorrhage in Japan, as elsewhere. HDL cholesterol levels were inversely related with ischemic stroke. Positive associations between serum triglyceride levels and coronary heart disease and ischemic stroke have also been observed in Japanese populations.[21] In our study, the prevalence of different components of metabolic syndromes in diabetic and non-diabetic were as follows: (a). Dyslipidemia (in diabetics 85.6% vs. in non-diabetics 78.3%), (b). hypertension (in diabetics 73.3% vs. in non-diabetics 34.2%), (c). obesity (≥ 90 cm in females/ ≥ 100 cm in males) (in diabetics 18.7% vs in non-diabetics 8.9%), (d). raised fasting blood sugar(FBS) (in diabetic group 94.1% vs. in non-diabetic group 7.11%), (e.) raised systolic blood pressure (SBP) (in diabetic group 62.2% vs. in non-diabetic group 58.8%) and (f). raised diastolic blood pressure(DBP) (in diabetics group 56.8% vs. in non-diabetics 44.2%).

In a study on elderly Russian people Victoria A. Metelskaya et al. the prevalence of MetS was found to be 41.7% in women and 26.8% in men. It tended to decrease with age in men, but not in women. MetS was inversely related to education in women, but not in men. The most prevalent individual components of MetS were as follows: hypertension (64.4%), abdominal obesity (55%), and decreased high density lipoprotein cholesterol (HDL C) (46%) for women; and hypertension (71%) and fasting hyperglycaemia (35.2%) for men. An elevated level of triglycerides (TG) was the rarest MetS component, affecting 23.5% of women and 22.1% of men. The higher female prevalence of MetS was attributable to abdominal obesity. MetS was found to be associated with markers of insulin resistance (IR), low-grade inflammation, and insufficient fibrinolysis.[22] We also find higher prevalence of MetS in our study and it was 55.9% among women and 40.2% among men ($P < 0.05$). The highest prevalence was present in patients aged more than 50 years (87%, $P < 0.05$).

The results of a study by Marilia B Gomes et al. showed that in population of patients with type 2 diabetes the estimated cardiovascular risk was correlated with lipid profile but not with glycemic control parameters. Patients with microvascular chronic complications had a higher estimated cardiovascular risk. These data could explain the failure of intensive glycemic control in reducing cardiovascular events observed in some studies.[23]

According to a study by Maggi S et al. study, MetS was strongly associated with an increased risk of diabetes (OR: 5.53, 95% CI: 2.89-10.60). After adjusting for its individual components and possible confounders, the MetS maintained an important role in predicting the incidence of diabetes (OR: 2.65, 95% CI: 0.97-7.24) together with the fasting glucose component (OR: 5.89, 95% CI: 2.89-11.98). Over the 4-year follow-up, participants with diabetes, but without the MetS, and subjects with the MetS, but without diabetes, had no significant risk of death compared with the reference group. Elderly subjects who had both the MetS and diabetes had almost double the risk of death vs the reference group (HR: 1.80, 95% CI: 1.04-3.12).[24]

In individuals with Metabolic Syndrome, it was found that moderate or high consumption of alcohol was related to higher prevalence of normal or increased level of HDL-c when compared to abstainers. Prevalence of hypertriglyceridemia was higher among individuals with high alcohol consumption (47.8%) compared with those with moderate consumption (22.7%) and abstainers (25.3%) ($p<0.0005$); therefore, a higher alcohol consumption in males could explain a higher prevalence of hypertriglyceridemia, as well as the association between moderate/high consumption alcohol with normal or high HDL-c. Despite higher plasma levels of HDL-c with alcohol consumption and the clear prevalence of alcohol consumption among men, there was no significant difference in HDL-c between genders.

In our study, patients over 50 years showed a higher prevalence of increased body mass index in women compared to men ($p=0.01$), which may explain the higher prevalence of increased waist circumference in women. Metabolic syndrome becomes more common with advanced age and increase body weight. In this study, after analyzing the prevalence ratio between inactive/active patients, it was concluded that inactive individuals were more likely to have Metabolic Syndrome.

This study has shown an increased prevalence of Metabolic Syndrome (49.5%), and through logistic regression analysis, has delineated the key risk factors driving morbidity. Most of the individual risk factors were more prevalent in women, compared to men; women were more likely to have Metabolic Syndrome (MetS). The most prevalent component was hypertension, followed by central obesity, low HDL-C and hypertriglyceridemia. Low educational status and obesity also have greater predictive effects on Metabolic Syndrome in Type 2 diabetics.

CONCLUSION

From the study it can be concluded that the life style and the diet pattern has been rapidly changing in recent decades, as reflected in many of its health indicators, and both impaired glucose metabolism and dyslipidaemia are emerging as important risk factors for CVD in the study population. In order to reduce the risk of CVD, subjects with metabolic disorder should reduce cardiovascular risk factors and improve their lifestyle. We understand that this is one of the few studies conducted in this part of world addressing different aspects involved in the metabolic syndrome and may create a challenge for physicians to control and prevent obesity, dyslipidaemia, impaired glucose metabolism and hypertension. These results suggest the need for deeper studies on this subject.

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