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Title: Metabolic syndrome and risk of major coronary events amongst the urban diabetic patients: North Indian Diabetes and Cardiovascular Disease Study-NIDCVD-2

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Keywords: Metabolic syndrome, Harmonized criteria of metabolic syndrome, Type 2 diabetes, cardiovascular disease, Asian Indians.

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Abstract: Objective
The present study aimed at estimating the prevalence of metabolic syndrome (MetS) and prospectively, evaluating cardiovascular events among Asian Indians type 2 diabetic subjects.
Methods
The sample comprised of 1522 type 2 diabetic mellitus (T2DM) subjects aged 25 -91 years, who participated in the North Indian Diabetes and cardiovascular Disease Study (2011-2014). The participants were screened for hypertension, dyslipidemia, obesity and cardiovascular events. Anthropometric, clinical and biochemical measurements were done in all subjects. The prevalence of MetS was estimated in all the subjects according to the harmonized criteria of 2009.
Results
The prevalence of MetS among urban Indian diabetic subjects was 71.9% and was significantly higher in females (86%) as compared to males (57.9%). To determine the independent predictors of the MetS in diabetic sample, binary logistic regression analyses were performed using demographic and biochemical parameters. Significant differences in the indices of generalized and abdominal obesity and lipids (Total cholesterol, High Density Lipoprotein) were observed ($p < 0.01$) in male: female and MetS and non-MetS comparisons. Regression analysis for prediction of CVD showed that family history, age, Body Mass Index (BMI), SBP, physical inactivity and hypertension independently and significantly predicted the disease outcome. Binary logistic regression analysis for prediction of CVD risk was found to be an independent risk/predictor (Odd Ratio (OR) =3.44, CI 1.31-9.01) along with higher age groups, BMI and hypertension.
Conclusion
The study demonstrated the high prevalence of MetS and its different components were positively associated with a higher risk of cardiovascular disease in north Indian diabetic subjects. Nevertheless, MetS is a major health problem in India, comprehensive population studies are warranted for estimation of incidence and prevalence, and education should be provided on its prevention and control to reduce the diabetes-related morbidity and mortality.

Highlights (for review)

1. The present study demonstrated a high prevalence of metabolic syndrome in an urban Indian diabetic population.
2. The prevalence of MS among urban Indian diabetic patients was 69.6% and was significantly higher in females (86%) as compared to males (57.9%).
3. Significantly differences in the indices of generalized and abdominal obesity (BMI, waist, WHR) and lipids (Total cholesterol, HDL-cholesterol) were observed in male: female and MS and non-MS comparisons.
4. Regression analysis for prediction of CHD showed that family history, age group classification, BMI, SBP, physical activity and hypertension independently and significantly predicted the disease outcome.
5. Binary logistic regression analysis for prediction of CHD risks was found to be an independent risk/predictor (OR=3.44, CI 1.31-9.01) along with higher age groups, BMI and hypertension.

Metabolic syndrome and risk of major coronary events amongst the urban diabetic patients: North Indian Diabetes and Cardiovascular Disease Study-NIDCVD-2

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ABSTRACT

Objective

The present study aimed at estimating the prevalence of metabolic syndrome (MetS) and prospectively, evaluating cardiovascular events among Asian Indians type 2 diabetic subjects.

Methods

The sample comprised of 1522 type 2 diabetic mellitus (T2DM) subjects aged 25 -91 years, who participated in the North Indian Diabetes and cardiovascular Disease Study (2011-2014). The participants were screened for hypertension, dyslipidemia, obesity and cardiovascular events. Anthropometric, clinical and biochemical measurements were done in all subjects. The prevalence of MetS was estimated in all the subjects according to the harmonized criteria of 2009.

Results

The prevalence of MetS among urban Indian diabetic subjects was 71.9% and was significantly higher in females (86%) as compared to males (57.9%). To determine the independent predictors of the MetS in diabetic sample, binary logistic regression analyses were performed using demographic and biochemical parameters. Significant differences in the indices of generalized and abdominal obesity and lipids (Total cholesterol, High Density Lipoprotein) were observed ($p < 0.01$) in male: female and MetS and non-MetS comparisons. Regression analysis for prediction of CVD showed that family history, age, Body Mass Index (BMI), SBP, physical inactivity and hypertension independently and significantly predicted the disease outcome. Binary logistic regression analysis for prediction of CVD risk was found to be an independent risk/predictor (Odd Ratio (OR) =3.44, CI 1.31-9.01) along with higher age groups, BMI and hypertension.

Conclusion

The study demonstrated the high prevalence of MetS and its different components were positively associated with a higher risk of cardiovascular disease in north Indian diabetic subjects. Nevertheless, MetS is a major health problem in India, comprehensive population studies are warranted for estimation of incidence and prevalence, and education should be provided on its prevention and control to reduce the diabetes-related morbidity and mortality.

Key Words

Metabolic syndrome, Harmonized criteria of metabolic syndrome, Type 2 diabetes, cardiovascular disease, Asian Indians.

1 Introduction

India is witnessing a depressing situation due to escalating incidence and prevalence of type 2 diabetes mellitus (T2DM) and its inevitable outcomes of cardiovascular diseases (CVD), diabetic neuropathy, nephropathy and retinopathy (Anjana et al., 2011; Mohan et al., 2010; Ramachandran et al., 1997). Recent estimates revealed that India currently has more than 65 million people with type 2 diabetes and this numbers is predicted to be doubled in next 20 years (Guariguata et al., 2014). Metabolic syndrome (MetS) is a constellation of metabolic risk factors comprising abdominal obesity, glucose intolerance, hyperinsulinaemia, hypertension and dyslipidemia characterized by low levels of HDL-cholesterol and elevated levels of triglycerides (Reaven, 1988). MetS has been reported as a risk factor for cardiovascular disease and mortality (Isomaa et al., 2001; Lakka et al., 2002). There was no internationally agreed criterion of defining MetS resulting variation in the global prevalence of MetS using different criteria. Recently, a joint scientific statement by various health organizations proposed to unify the diagnostic criteria of metabolic syndrome with population and country specific waist circumferences (Alberti et al., 2009). Both diabetes and CVD are consequences of the insulin resistance syndrome, also known as the metabolic syndrome (Meigs, 2010; Wilson et al., 2005). Each component of the cluster conveys increased risk of CVD, but as a combination they become much more powerful. Despite its high prevalence, little is known of the prospective association of the metabolic syndrome with cardiovascular and overall mortality. A very few systematic studies on the prevalence of MetS have been reported from the Indian subcontinent (Ramachandran et al., 2003). The present study was planned to estimate the prevalence of MetS in T2DM subjects according to the harmonized criteria of metabolic syndrome (2009) and evaluate the risk of cardiovascular events in urban Asian Indian population.

2 Material and Methods

2.1 Human Subjects: The present study included 1522 diabetic individuals (887 males and 635 females). The North Indian Diabetes and Cardiovascular Disease Research (NIDCVD) study was planned in 2011 with the aim of investigating the interplay of genetic and environmental factors associated with high prevalence of T2DM and cardiovascular diseases in Indian population (Bhatti et al., 2014). The T2DM subjects were diagnosed as per the criteria established by American Diabetes Association (American Diabetes Association, 2004) i.e. a medical record of either a fasting plasma glucose (FPG) levels ≥7.0 mmol/l or ≥126 mg/dl after a minimum 12-hour fast or 2-hour post glucose level (oral glucose tolerance test or 2-h OGTT) ≥11.1 mmol/l or ≥200 mg/dl on more than

one occasion with symptoms of diabetes. The impaired glucose tolerance (IGT) was defined as the FPG levels 100 mg/dl (5.6 mmol/l) but <126 mg/dl (7.0 mmol/l) or 2-h OGTT of ≥140 mg/dl (7.8 mmol/l) but <200 mg/dl (11.1 mmol/l). The diagnosis of T2DM was based on clinical and medical records of the participant. In the absence of medical record information, we confirmed a self-reported T2DM case by establishing that there is regular treatment with hypoglycemic medication or by testing the self-reported T2DM cases by performing 2-h OGTT. Informed written consent was obtained from all individual participants included in the study. This study was ethically approved by Institutional Ethics Committee of Post Graduate Institute of Medical Education and Research, Chandigarh, India.

2.2 Definition of Metabolic Syndrome

Metabolic Syndrome was defined according to the recent harmonized criteria (Alberti et al., 2009). The definition of MetS included five components: (1) central obesity (waist circumference ≥ 90 cm for Asian Indian men and ≥ 80 cm for Asian Indian women; (2) elevated blood pressure: systolic ≥ 130 mmHg, diastolic ≥ 85 mmHg, or known treatment for hypertension; (3) elevated triglycerides: fasting plasma triglycerides ≥ 150 mg/dL (1.7 mmol/L), drug treatment for elevated triglycerides is an alternate indicator; (4) low HDL-C: fasting HDL-C < 1.0 mmol/L in men and < 1.3 mmol/L in women, drug treatment for reduced HDL-C is an alternate indicator; and (5) hyperglycemia: fasting glucose level of ≥ 5.6 mmol/L (≥ 100 mg/dL) or known treatment for diabetes, drug treatment of elevated glucose is an alternate indicator. MetS was positive if an individual had at least three positive of these 5 components. All patients previously diagnosed with and were receiving medications for hypertension, diabetes or dyslipidemia were included in the study and were deliberated as having these risk factors.

2.3 Inclusion/ Exclusion criteria: Male and female volunteer T2DM, participants aged>25 years, belonging to north Indian states (Punjab, Haryana, Himachal Pradesh, Delhi and J&K) were included. The individuals belonging to South, East and Central Indian origin, type-I diabetes (T1DM) or family member with T1DM, rare form of T2DM sub-type were excluded.

2.4 Anthropometric measurements

Standard anthropometric measurements were performed including height, weight, waist and hip circumferences and blood pressure. Waist and Hip circumference was measured with a metal tape using standard procedures. Height was measured with a stature meter and weight with a portable

balance beam scale. Blood pressure was measured by Omron blood pressure machine in sitting position from the left arm resting on the table, with legs uncrossed and feet flat. Direct physical examination was performed to evaluate the severity and progression of diabetes-related complications reported in patient's medical records.

2.5 Biochemical measurements:

Blood samples were drawn in plain and EDTA coated vials. Fasting and random blood glucose levels were measured using a portable glucometer (OptiumXceed, Abbott Diabetes Care Inc. USA). Calibration of the glucometer was routinely verified using test strips provided by the manufacturers. Serum was used for quantization of lipid profile [total cholesterol (TC), triglycerides (TG), high density lipoprotein (HDL) cholesterol, and creatinine levels. Low density lipoprotein (LDL) level was calculated by using Friedewald formula i.e. LDL-C = TC – [HDL-C – (TG in mg/dl/5)]. All the quantitative parameters were measured by following manufacturer's instructions using biochemistry autoanalyzer.

2.6 Phenotypic Evaluation of Study Subjects

Information regarding age at the time of diagnosis, Coronary Heart Disease or stroke, coronary artery bypass graft (CABG) or angioplasty, and medication was obtained from patient records. Cardiovascular disease (CVD) was diagnosed based on a history of documented myocardial infarction and/or drug treatment for CVD (aspirin or nitrates). Hypertension was defined as a self-reported history of a systolic blood pressure (SBP) of >140 mm Hg and/or diastolic blood pressure (DBP) of >90 mm Hg or subjects who were receiving drug treatment for hypertension. Ocular complications were recorded based on medical records. Neuropathy was documented as tingling or burning of fingers or toes, numbness, or diminished sensation at lower extremities and /or sharp pains or cramps, sexual dysfunction, uncontrolled urinations, perfused sweating at night or while eating, and hearing loss.

2.7 Derived Measures

Quantitative measures of obesity include the body mass index (BMI), waist-to-hip ratio (WHR) and per cent body fat. BMI was calculated according to Quetelet equation i.e. (BMI = weight in kilograms/height in meters squared). WHR was calculated as ratio of abdomen to hip circumferences.

Body fat percentage (BF%) was calculated using following formulae (Lean et al., 2001):

BF% for men = [(0.567 × waist circumference in cm) + (0.101 × age in years)] − 31.8; and

BF% for women = [(0.438 × waist circumference in cm) + (0.221 × age in years)] − 9.4.

World Health Organization recommended BMI threshold values for Asian populations (Consultation, 2004) are: a) <23 kg/m2 for low risk, b) 23–27.5 kg/m2 for increased risk, and c) >27.5 kg/m2 for high risk.

Abdominal obesity was measured according to the cut-off values for normal anthropometric variables proposed for South Asians i.e. WHR <0.89 for men and <0.81 for women (Snehalatha et al., 2003).

2.8 Statistical Analysis

Continuous and categorical variables were analysed by unpaired t-tests and $\chi 2$-square test respectively. Comparisons between males and females and MetS and Non-MetS categories were carried out using IBM-SPSS for Windows, version 19 (SPSS, Inc., Chicago, IL)**.** All the p-values <0.05 (two-tailed) were considered as significant difference. Logistic regression analysis was carried out to correlate various clinical parameters with disease. Bonferroni corrected p-value was used for the assessment of significance which controlled the multiple comparisons.

3 Results

Of all the 1522 diabetic subjects (887 males and 635 females), 55.9% were receiving oral antihyperglycemic medications (OAHM), 4.1% were on insulin therapy, 19.6 % were on insulin therapy alongwith OAHM, 9.1% were not taking any regular medication and 11.2% were maintaining their glucose levels by diet and exercises only. Physical activity was low in 65.5% subjects, 7.3% had a sedentary lifestyle and only 27.2% are very active. Mean age of diagnosis and duration of diabetes was 50.8 years and 7.2 years, respectively. A positive family anamnesis of diabetes was documented in more than 60% of diabetic subjects. Central obesity ($p<0.0001$) and low HDL ($p<0.0001$) were also significantly more prevalent in women. Men were more likely to have hypertension ($p=0.001$).

Considering the entire cohort of 1522 diabetic patients, MetS was prevalent in 72% of Asian Indian diabetic subjects. The MetS was more prevalent in women (86%) as compared to men

(57.9%), leading to statistically significant differences between the genders (chi-square =136.7, p<0.001). The prevalence of MetS in the study subjects by their age groups was shown in Fig. 1. No significant difference in the prevalence of MetS was observed in male and female subjects under the age group of <50 years. However, high prevalence was observed in both males and females in age groups of 50-60 years (32.3% vs. 37.4%) and 60-70 years (26.3 vs 27.8%) (Fig. 2). Considering the 1060 diabetic patients having diagnosed with metabolic syndrome, it was found that 159 (15.0%) subjects were positive for all five risk factors of MetS, 372 (35.1%) subjects had four risk factors, and 529 (49.9%) subjects had three risk factors (Fig. 4). Metabolic risk factors were more prevalent in women with five components of MetS (24.2% in women vs. 5.3% in men) and four components of MetS (40.3% in women vs. 29.6% in men). However higher proportion of 3 components of MetS was observed in men than women (65.2% vs. 35.5%).

Table 1 show the anthropometric and clinical parameters of MetS and Non-MetS subjects. The mean age of the Non-MetS subjects was comparable to that of the MetS subjects (58.05±11.4 vs 58.01.6±10.9, p=0.95). No significance difference in the duration of diabetes was observed in MetS and Non-MetS subjects. As expected MetS subjects had higher values of BMI, waist and hip circumferences, WHR, SBP, DBP, glucose, cholesterol, TG, LDL, and VLDL while HDL levels were lower. Comparison of males and females showed statistically significant differences in a number of parameters for MetS category which included BMI, hip circumference, and Cholesterol and LDL levels. Males in MetS category were having higher values for BMI, hip circumference, glucose, cholesterol and LDL. In Non-MetS category, males were having higher WHR, whereas females carried higher body fat, higher glucose and cholesterol (Table 1).

Overall distribution of socioeconomic characteristics were similar in MetS and Non-MetS subjects and males and females diabetic subjects (Table 2). Analysis of clinical outcomes/conditions according to MetS criteria showed significant differences between MetS and Non-MetS diabetics for Hypertension in overall sample and male and female subgroups (p<0.0001) as shown in Table 3. Women had a significantly higher prevalence of abdominal obesity (p<0.0001) and low values of HDL (p<0.0001), while men were significantly more likely to have hypertension (p<0.0001) and hypertriglyceridemia (p<0.0001).

To determine the independent predictors of the MetS in diabetic sample, binary logistic regression analyses were performed using demographic and biochemical parameters and results are given in table 4. Regression analysis for prediction of CVD showed that family history, age, BMI, SBP, physical inactivity and hypertension independently and significantly predicted the disease outcome

(Table 5). MetS risk factors and established biochemical parameters (like Cholesterol, TG, HDL, LDL, VLDL) did not contribute significantly to CVD risk in this sample of diabetic individuals.

4 Discussion

The high prevalence of type 2 diabetes in Asian Indians poses a major health and economic burden to the country and reported to anguish the Asian Indians a decade earlier than the rest of the world. The metabolic syndrome, a cluster of altered glucose metabolism, abdominal obesity, body fat distribution, hypertension and dyslipidemia, is associated with consequent increase in diabetes and cardiovascular diseases. The prevalence of MetS in Asian Indians varies according to the region, the extent of urbanization, lifestyle patterns, and socioeconomic/cultural factors. Recent studies reported the higher prevalence of MetS in India's major cities (Gupta et al., 2004; Manjunath et al., 2014; Ramachandran et al., 2003; Singh et al., 2007). Since the implications of MetS for healthcare are substantial, it is essential to establish the prevalence of this condition among north Indian diabetic patients. The prevalence of MetS in the current study showed gender-specific differences. Findings of the present study indicate that MetS is very common with an estimated overall prevalence of 72% in Asian Indian diabetic subjects. Our study mirrors the observations of previous studies which documented a high prevalence of MetS among individuals with T2DM (Raman et al., 2010; Surana et al., 2008). This study provides estimates of the MetS prevalence in north Indian urban diabetic population which is nearly 30% higher in the females and nearly 30-40% higher prevalence in the general urban Indian population. Because South Asians develop metabolic abnormalities at a lower body mass index and waist circumference than other groups, conventional criteria underestimate the prevalence of MetS by 25% to 50% (Enas et al., 2007). Systematic studies are lacking from India to estimate prevalence of MetS in this region, but overall trend is on increase (Agrawal et al., 2011; Gupta et al., 2004). Ramachandran et al reported a prevalence of 41% in urban area of Chennai using modified ATP-III criteria among adults aged 20 to 75 years (Ramachandran et al., 2003). They also reported higher prevalence of MetS in women than men (46.5% vs 36.4%). Approximately 30-50% of urban South Asians have MetS (Deepa et al., 2007; Mohan et al., 2001). The prevalence increases to >73% in people with diabetes with women having even higher prevalence (83%) compared to men (65%) (Raman et al., 2010). Recent studies on diabetic subjects in different parts of the world reported 75.6% prevalence of MetS from the USA (Bruno et al., 2004) and 77% prevalence of MetS in diabetic Indian immigrants in the USA (Foucan et al., 2006) and 79.7% in Pakistan (Imam et al., 2007). Indian immigrants with T2DM had a 5-fold higher risk of MetS than the general population group. Our

results are similar to these studies measuring the prevalence of metabolic syndrome in diabetic population.

According to the recent definition of metabolic syndrome (Alberti et al., 2009) with recommended waist circumference for Asian Indians, the risk of MetS was increased in women, subjects with elevated glucose levels, dyslipidemia and hypertension. As expected, there were significant differences between males and females and MetS and non-MetS subjects for a range of demographic and clinical parameters. These values were highly significant even after the Bonferroni correction for multiple comparisons. Waist circumference, hypertension and hyperglycemia contributed as independent predictors of MetS in this population using regression analysis. The highest odds ratio was observed for presence of hypertension (OR =35.95, CI=20.98-61.58), suggesting that hypertension is highly prevalent in this region and specific treatment and lifestyle interventions may be required.

It is well known that cardiovascular morbidity and mortality is associated with the individual components of metabolic syndrome (Isomaa et al., 2001). We tested this using regression analysis for prediction of CVD risks, central obesity was found to be an independent risk/predictor along with higher age categories, BMI and hypertension. Currently available evidence suggests that MetS is associated with significantly increased risk of incident cardiovascular disease, all-cause and cardiovascular death (Ford, 2005; Galassi et al., 2006; Mottillo et al., 2010). A previous study demonstrated that in diabetic patients, the presence of metabolic syndrome is associated with a 5-fold increase in CVD risk independent of age, sex, smoking status, and glycosylated haemoglobin (Bonora et al., 2004). The analysis also showed that higher physical activity, lower SBP, lower weight protects against development of the CVD. This is consistent with other studies which suggest MetS increases risk of cardiovascular diseases (Gami et al., 2007). Previous studies also reported that the increasing rates of obesity are associated with increasing rates of diabetes, which in turn are associated with increasing rates of CVD in the Framingham Heart Study (Meigs, 2010). The link between MetS and increased CVD risk has also reported in many large scale clinical intervention trials in western populations (Bonora et al., 2004; Girman et al., 2004; Sattar et al., 2003). Studies from Indian subcontinent are limited. In our analysis, it is clear that MetS individuals have three fold increased risk of CVD compared to non-MetS individuals. A study in a Italian elderly population had shown, among MetS components, all-cause mortality is better predicted by IFG in all subjects and in women, and by low HDL-C in women; whereas CVD mortality is better predicted by IFG and low HDL-C in women (Zambon et al., 2009) . Although

dyslipidemia was more prevalent in MetS subjects of this study, one interesting aspect of this analysis is the lack of significance for lipid parameters in the development of CVD in this population. This may be because of the regular use of the lipid lowering drugs used by >80% of the CVD and hypertensive patients of this study. Previous studies have shown the reduction in cardiovascular morbidity and mortality in diabetic patients with statin therapy (Sheng et al., 2012). A combination of hypertriglyceridemia, low levels of HDL-cholesterol and high levels of small dense low-density lipoprotein is particularly seen in Asian Indians (Misra et al., 2004). Furthermore, Asian Indians have at least double the risk of CVD than that of whites, even when adjusted for the presence of diabetes and MetS (Enas et al., 2007). This again indicates that South Asian/Asiatic Indians have different risk factors for development of CVD. This study was the first study in north India that has evaluated the prevalence of MetS in type 2 diabetic subjects. Our study has some limitations also that must be accounted for when interpreting our findings. This was a cross-sectional research study conducted in a research institute with targeted recruitment of patients and controls. Therefore, whether our findings reflect those from a broader population with diabetes at the community or primary care level is not known. However this should not affect any interpretations of MetS prevalence and its contributing factors or its effect on the development of CVD.

In conclusion, our analyses show that MetS is highly prevalent in this north Indian urban diabetic population. It is clear from our analyses, MetS, as defined by the modified NCEP/ATP-III criteria, appears to almost triple the risk of CVD in this population. This is not surprising since metabolic syndrome contains well-established cardiovascular risk factors such as hypertension and dyslipidemia. Hypertension seems to be the most significant risk factor for both MetS and CVD in this population which may require targeted therapeutic and lifestyle interventions to reduce the disease burden in this region. In addition healthcare professionals must support patients with MetS in prevention or delaying progression to diabetes, cardiovascular disease, and other related complications. This study despite its limitations contributes to mapping the prevalence of MetS worldwide, particularly with regards to people with diabetes in North India.

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Conflict of Interest: None declared

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Figure
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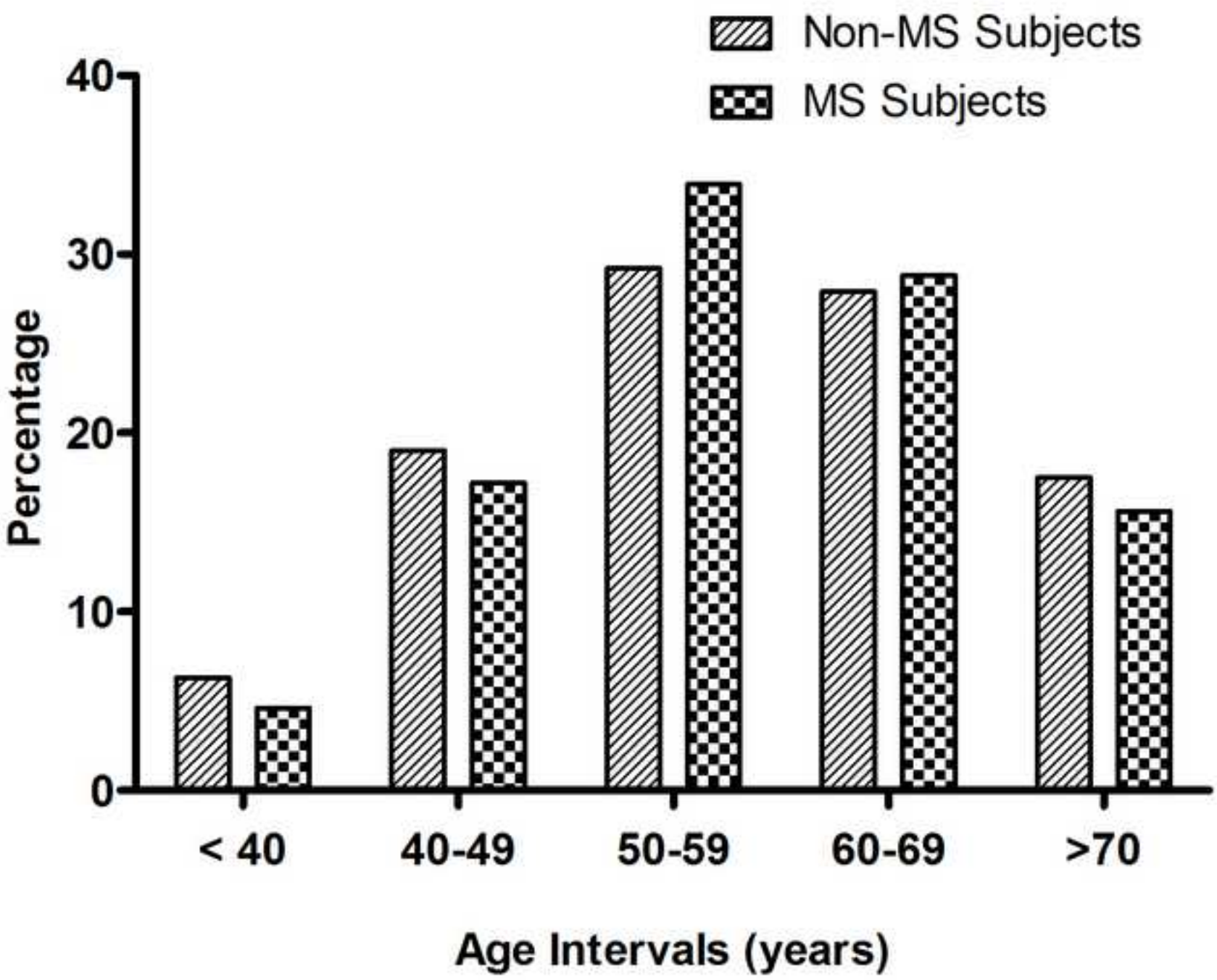

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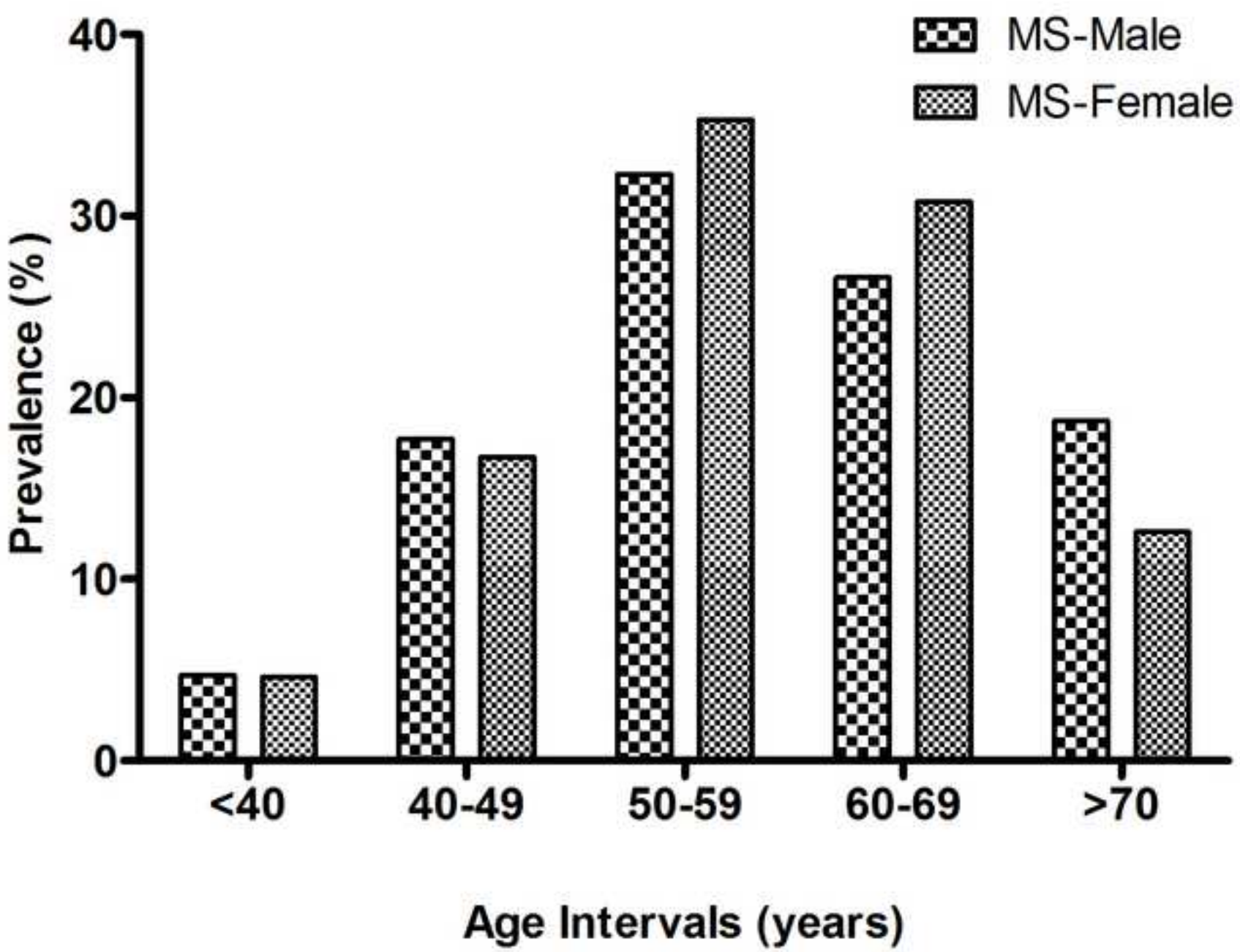

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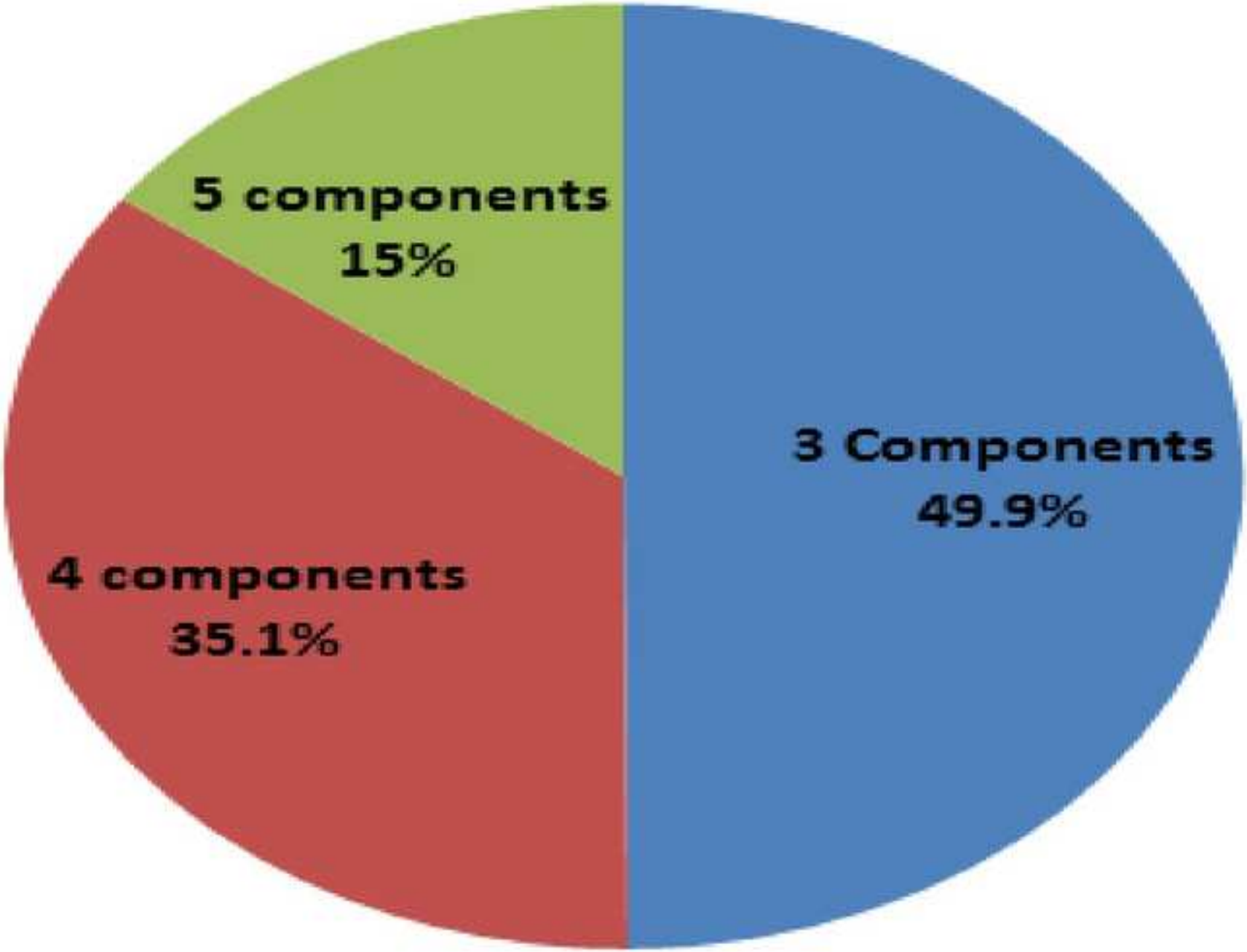

Table

Figure Legends

Fig 1. Distribution of study subjects by age.

Fig 2. Prevalence of MS in diabetic subjects by Age and Sex.

Fig. 3 : Proportion of metabolic risk factors in patients with metabolic syndrome.

Table 1. Demographic and clinical characteristics according to modified NCEP ATP III criteria of MetS among Asian Indian Diabetic Subjects

Parameter		Men			Women			p-Value Male vs. Female	Total		
		N	Mean±SD	p- value	N	Mean±SD	p- value		N	Mean±SD	p- value
Age (Years)	Non-MetS	373	58.79±11.76	0.64	89	54.97±10.99	0.35	0.006	462	58.05±11.70	0.95
	MetS	514	58.42±11.36		546	57.63±10.42		0.23	1060	58.01±10.89	
BMI (kg/m^2)	Non-MetS	373	25.08±3.81	<0.0001	89	25.63±4.77	<0.0001	0.25	462	25.19±4.01	<0.0001
	MetS	514	26.70±4.15		546	27.99±4.91		<0.0001	1060	27.36±4.60	
Waist (inch)	Non-MetS	373	36.36±3.01	<0.0001	89	34.63±3.87	<0.0001	<0.0001	462	36.03±3.26	<0.0001
	MetS	514	38.26±4.24		546	38.03±4.38		0.39	1060	38.14±4.31	
Hip (inch)	Non-MetS	373	37.39±2.87	<0.0001	89	37.69±4.08	<0.0001	0.42	462	37.45±3.13	<0.0001
	MetS	514	38.67±3.43		546	39.72±4.34		<0.0001	1060	39.21±3.96	
WHR	Non-MetS	373	0.97±0.05	<0.0001	89	0.92±0.06	0.01	<0.0001	462	0.96±0.06	0.075
	MetS	514	0.99±0.06		546	0.98±0.48		0.47	1060	0.98±0.35	
Systolic BP	Non-MetS	373	141.54±20.52	<0.0001	88	136.08±21.26	<0.0001	0.03	461	140.50±20.75	<0.0001
	MetS	514	148.12±26.19		546	146.19±22.35		0.64	1060	147.13±24.30	
Diastolic BP	Non-MetS	373	82.61±10.95	<0.0001	88	80.93±8.86	0.007	0.18	461	82.29±10.59	<0.0001
	MetS	514	85.55±12.38		546	83.91±12.38		0.19	1060	84.71±12.40	
Bodyfat %	Non-MetS	373	26.50±4.38	<0.0001	89	41.22±4.73	<0.0001	<0.0001	462	29.34±7.32	<0.0001
	MetS	514	29.20±6.15		546	45.59±5.37		<0.0001	1060	37.64±10.01	
Glucose (mg/dL)	Non-MetS	358	164.64±64.03	0.92	82	173.98±70.00	0.64	0.24	440	166.38±65.20	0.74
	MetS	499	165.05±61.12		520	170.09±73.69		0.12	1019	167.63±67.84	
Cholesterol (mg/dL)	Non-MetS	294	171.89±43.07	<0.0001	46	183.83±38.91	0.34	0.08	340	173.50±42.68	<0.0001
	MetS	501	183.81±48.66		502	189.73±51.35		<0.0001	1003	186.77±50.08	
Triglycerides (mg/dL)	Non-MetS	294	136.13±72.64	<0.0001	46	125.07±37.25	<0.0001	0.31	340	134.63±68.98	<0.0001
	MetS	501	206.04±110.62		502	177.48±86.31		0.17	1003	191.74±100.18	
HDL (mg/dL)	Non-MetS	294	42.41±8.07	<0.0001	46	46.93±12.36	<0.0001	0.001	340	43.02±8.89	<0.0001
	MetS	501	37.09±8.55		502	39.05±8.68		0.19	1003	38.07±8.67	
LDL (mg/dL)	Non-MetS	294	102.27±39.42	0.28	46	111.89±37.26	0.57	0.12	340	103.57±39.22	0.008
	MetS	501	105.52±44.31		502	115.19±45.78		<0.0001	1003	110.36±45.29	
VLDL (mg/dL)	Non-MetS	294	27.22±14.53	<0.0001	46	25.01±7.45	<0.0001	0.31	340	26.92±13.80	<0.0001
	MetS	501	41.21±22.12		502	35.49±17.26		0.17	1003	38.35±20.04	
Creatinine (mg/dL)	Non-MetS	288	0.91±1.08	0.9	46	0.88±0.58	0.15	0.18	334	0.91±1.02	0.25
	MetS	480	0.93±1.39		484	0.74±0.89		0.004	964	0.83±1.17	

Data values written as mean ± SD. BP, Blood Pressure; TG, Triglycerides; WC, Waist Circumference; BMI, Body Mass Index; HDL, High Density Lipoprotein; LDL, Low Density Lipoprotein; VLDL, Very Low Density Lipoprotein

Table 2. Socioeconomic Characteristics of MetS and Non-MetS Subjects among Asian Indian Diabetic Subjects.

Characteristic		Male			Female			Total		
		Non-MetS	MetS	p	Non-MetS	MetS	p	Non-MetS	MetS	p
Education	Total No.	372	513		89	544		461	1057	
	Illiterate	5.6%	5.4%		11.2%	16.4%		6.7%	11.1%	
	Primary	24.5%	22.8%		37.1%	31.4%		26.9%	27.2%	
	Secondary	28.8%	28.3%		24.7%	23.5%		27.9%	25.8%	
	Diploma	5.9%	6.0%	0.96	1.1%	4.0%	0.42	4.9%	5.0%	0.11
	Degree	35.2%	37.4%		25.4%	24.6%		33.4%	30.8%	
Economic Status/ Job grade	Total No.	372	512		89	544		461	1056	
	Low income	10.0%	17.8%		6.4%	6.4%		9.1%	11.9%	
	Middle income	76.6%	72.1%	0.01	87.6%	84.6%	0.81	78.8%	78.5%	0.13
	High income	13.4%	10.1%		6.7%	9.0%		12.1%	9.6%	
Physical activity	Total No.	364	506		89	545		453	1051	
	Sedentary	7.4%	4.5%		5.6%	10.3%		7.1%	7.5%	
	Moderate	59.1%	62.2%	0.24	76.4%	73.2%	0.55	62.4%	67.9%	0.03
	Very active	33.5%	33.2%		18.0%	16.5%		30.5%	24.5%	
Parents affected	Total No.	373	514		89	546		462	1060	
	None	56.0%	53.1%		57.3%	57.1%		56.3%	55.2%	
	Father	15.0%	15.8%		16.9%	13.0%		15.4%	14.3%	
	Mother	19.6%	20.0%	0.79	16.9%	18.3%	0.71	19.0%	19.1%	0.68
	Both	9.4%	11.1%		9.0%	11.5%		9.3%	11.3%	

Data values written as percent

Table 3. Clinical Conditions in MetS and Non-MetS Categories among Asian Indian Diabetic Subjects

Clinical Conditions	Male		P value	Female		P value	Total		P value
	Non-MetS N=373	MetS N=514		Non-MetS N=89	MetS N=546		Non-MetS N=462	MetS N=1060	
CVD	27.1	30		20.2	20.7	0.92	25.8	25.2	0.82
Hypertension	33.8	77.6	<0.0001	16.9	71.8	<0.0001	30.5	74.6	<0.0001
Retinopathies	34.3	35.2	0.78	33.7	36.6	0.59	34.2	36	0.51
Cataract	16.9	17.5	0.81	14.6	18.1	0.42	16.5	17.8	0.51
Neuropathies	42.1	36.6	0.1	49.4	52.6	0.58	43.5	44.8	0.64
Nephropathies	3.2	6.8	0.02	2.3	4.6	0.31	3	5.7	0.03
Diabetic Foot	4	5.3	0.39	3.4	2.6	0.66	3.9	3.9	0.98
Skin/UTI infection	12.9	18.3	0.03	21.3	20.1	0.79	14.5	19.2	0.03
Stroke	2.7	4.1	0.26	2.2	3.1	0.66	2.6	3.6	0.32

Data values written as percent

Table 4. Regression analysis for having MetS among Asian Indian Diabetic subjects

Parameters	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Upper	**Lower**
SEX	**-7.832**	**2.395**	**10.691**	**1**	**.001**	**.000**	**.000**	**.043**
Age	.024	.021	1.343	1	.247	1.025	.983	1.068
Family history of T2DM			.628	3	.890			
Father affected	-.101	.301	.113	1	.736	.904	.501	1.629
Mother affected	.148	.270	.298	1	.585	1.159	.682	1.969
Both Parents affected	.120	.345	.120	1	.729	1.127	.573	2.217
BMI	-.386	.260	2.205	1	.138	.680	.408	1.131
WC	**.638**	**.187**	**11.598**	**1**	**.001**	**1.893**	**1.311**	**2.734**
Hip	-.051	.068	.567	1	.451	.950	.831	1.086
WHR	-.190	.749	.064	1	.800	.827	.191	3.588
SBP	-.003	.006	.349	1	.555	.997	.985	1.008
DBP	.006	.011	.317	1	.573	1.006	.985	1.027
Body fat%	-.234	.135	2.998	1	.083	.791	.607	1.031
Physical Activity			2.854	3	.415			
Moderately active	.920	.804	1.309	1	.253	2.509	.519	12.133
Very active	1.005	.711	1.994	1	.158	2.731	.677	11.012
Hypertension	**3.582**	**.275**	**170.122**	**1**	**.000**	**35.949**	**20.985**	**61.582**
Glucose	**.003**	**.002**	**3.915**	**1**	**.048**	**1.003**	**1.000**	**1.006**
Total Cholesterol	.158	.756	.044	1	.834	1.171	.266	5.151
Triglycerides	-.396	.765	.267	1	.605	.673	.150	3.019
HDL-Cholesterol	-.299	.756	.156	1	.692	.741	.168	3.265
LDL-Cholesterol	-.156	.756	.043	1	.836	.855	.194	3.762
VLDL-Cholesterol	1.921	3.876	.246	1	.620	6.830	.003	13601.8
Constant	10.607	12.617	.707	1	.400	40431.5		

SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; WC, Waist Circumference; WHR, Waist Hip Ratio; BMI, Body Mass Index; HDL, High Density Lipoprotein; LDL, Low Density Lipoprotein; VLDL, Very Low Density Lipoprotein

Table 5. Logistic Regression for CVD prediction among Asian Indian Diabetic Subjects

Parameter	B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
MetS ATP-III Classification	**1.234**	**0.492**	**6.293**	**1**	**0.012**	**3.436**	**1.310**	**9.014**
Sex	1.033	1.578	.428	1	.513	2.810	.127	61.976
Age	-.019	.026	.569	1	.451	.981	.932	1.032
Parents affected			7.317	3	.062			
Father affected	**-.570**	**.241**	**5.585**	**1**	**.018**	**.566**	**.353**	**.907**
Mother affected	.009	.191	.002	1	.964	1.009	.693	1.467
Both parents affected	-.394	.275	2.056	1	.152	.674	.394	1.155
Age range			8.645	4	.071			
40-49 yrs	.724	.618	1.373	1	.241	2.063	.615	6.924
50-59 yrs	**1.406**	**.700**	**4.037**	**1**	**.045**	**4.079**	**1.035**	**16.076**
60-69 yrs	**1.987**	**.848**	**5.484**	**1**	**.019**	**7.292**	**1.383**	**38.463**
>70	**2.171**	**1.048**	**4.290**	**1**	**.038**	**8.766**	**1.124**	**68.390**
BMI	**.368**	**.159**	**5.369**	**1**	**.021**	**1.445**	**1.058**	**1.974**
WC (inch)	.109	.174	.392	1	.531	1.115	.793	1.569
Hip (inch)	-.129	.128	1.022	1	.312	.879	.684	1.129
WHR	-1.011	4.794	.044	1	.833	.364	.000	4381.196
SBP	**-.014**	**.004**	**10.429**	**1**	**.001**	**.987**	**.978**	**.995**
DBP	.003	.007	.126	1	.722	1.003	.988	1.017
Body fat%	.046	.091	.260	1	.610	1.047	.877	1.251
Physical activity			**10.346**	**3**	**.016**			
Moderately active	**-3.247**	**1.113**	**8.504**	**1**	**.004**	**.039**	**.004**	**.345**
Very active	**-3.200**	**1.083**	**8.736**	**1**	**.003**	**.041**	**.005**	**.340**
Hypertension	**1.150**	**.228**	**25.386**	**1**	**.000**	**3.158**	**2.019**	**4.941**
Glucose	-.001	.001	.523	1	.470	.999	.997	1.001
Total Cholesterol	-.025	.538	.002	1	.963	.975	.339	2.802
Triglycerides	.191	.648	.087	1	.768	1.210	.340	4.308
HDL-Cholesterol	.014	.539	.001	1	.979	1.014	.353	2.915
LDL-Cholesterol	.014	.538	.001	1	.979	1.015	.353	2.915
VLDL-Cholesterol	-.939	3.337	.079	1	.778	.391	.001	270.424
MetS Risk Factors			1.570	4	.814			
MetS-Risk Factors (2)	-.205	.374	.299	1	.584	.815	.391	1.697
MetS-Risk Factors (3)	-.335	.406	.680	1	.410	.716	.323	1.586
MetS-Risk Factors (4)	-.163	.484	.114	1	.735	.849	.329	2.191
MetS-Risk Factors (5)	-.324	.585	.308	1	.579	.723	.230	2.274
Constant	-16.219	9.309	3.036	1	.081	.000		