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Original Article

A case control study of clinical and biochemical parameters of metabolic syndrome with special attention among young and middle aged population

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ABSTRACT

Background: Metabolic syndrome (MS) increases the risk of heart disease, stroke, and other complications.
Aim: The aim of this study was to assess the clinical and biochemical parameters of MS and its complications (cerebrovascular accidents, cardiovascular accidents, DN or chronic kidney disease (CKD) compared with healthy controls especially among the younger population in Northern India.
Material and methods: A total of 245 (healthy, MS and it's complicated) aged 18–70 years participated in the Open-Label, Single Centered; hospital-based random selection case-control comparative study. All anthropometric and biochemical assessment was done after proper consent. The metabolic syndrome was determined by IDF criteria.
Results: The key risk parameters in three groups i.e. Control, Metabolic syndrome, and Complicated was TG (96.5 ± 46.9, 194.1 ± 87.8, 148.0 ± 102.2). LDL (91.2 ± 27.2, 114.0 ± 31.8, 69.1 ± 42.5, BP (120.1 ± 9.9, 139.3 ± 13.3, 132.1 ± 15.0) and high fasting glucose (81.1 ± 13.7, 164.5 ± 84.3, 138.0 ± 74.5). The hs-CRP is also significantly increased in the complicated group. The subanalysis of data also indicates that younger middle age (36–55 years) group both male and female is obese, hypertensive, diabetic with lipid abnormality according to IDF criteria. Conclusion: The risk factors like high TG, low HDL, high BP, and high fasting glucose were found higher particularly in younger population which may lead to diagnosis & complications of diabetes, hypertension and lipid abnormality. Due to changing physiology in young and middle age population these individuals are moving towards metabolic syndrome easily and needs frequent monitoring, preventive checkups, and lifestyle changes to prevent complications.

1. Introduction

Metabolic syndrome (MS) is a cluster of conditions increased blood pressure, high blood sugar, excess body fat around the waist, and abnormal cholesterol or triglyceride levels that occur together, increasing the risk of heart disease, stroke and diabetes [1]. It is now well known that MS is a risk factor for increased cardiovascular mortality, diabetic nephropathy (DN) and morbidity [2,3].

The MS is a major and escalating public-health and clinical challenge worldwide in the wake of urbanization, surplus energy intake, increasing obesity, and sedentary life habits. Total number of people with diabetes is projected to double between 2000 and 2030 with a significantly greater rise in Asia [4,5]. MS confers a 5-fold increase in the risk of type 2 diabetes mellitus (T2DM) and 2-fold the risk of developing cardiovascular disease (CVD) over the next 5–10 years [4,6]. Patients with MS are at 2–4 folds more likely to have stroke and 3–4 fold likelihood of myocardial infarction (MI) in their lifetime [7–9]. Further, patients with the MS are at 2- to 4-fold increased risk of stroke, a 3- to 4-fold increased risk of

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myocardial infarction (MI), and 2-fold the risk of dying from such an event compared to those without the syndrome (7) regardless of a previous history of cardiovascular events [9]. MS is considered as a *first order* risk factor for atherothrombotic complications. Its presence or absence should therefore be considered an indicator of long-term risk. Epidemiologists in India and international agencies such as the WHO have been sounding an alarm on the rapidly rising burden of CVD for the past 15 years. It is estimated that by 2020, CVD will be the largest cause of disability and death in India, with 2.6 million Indians predicted to die due to CVD [2,10].

MS is an asymptomatic, pathophysiological state characterized by obesity, insulin resistance, hypertension, dysglycaemia, and dyslipidaemia in combinations [4]. While several criteria and definitions have been used to identify MS [1,4,7,11]; it is generally agreed that a combination of three or more of the following components must be present: large waist circumference, elevated triglycerides, low HDL-cholesterol, raised blood pressure, and elevated fasting blood glucose. MS in South Asians appears to differ according to which component risk factors present. The prevalence of obesity and MS is rapidly increasing in India and other South Asian countries, leading to increased mortality and morbidity due to CVD and (T2DM) [12,13]. Approximately about one third of urban South Asians have evidence of the MS [14]. Moreover, insulin resistance was observed to be there in nearly 30% of Asian Indian children and adolescents and many exhibit features of MS [15]. Since, MS and obesity track into adulthood, these clinical entities need to be recognized early in the life-course for effective prevention. Earlier, Bhat et al. [16] studied the prevalence of the MS among North Indian Adolescents (10–18 yr). He concluded that research is needed to know the effects of puberty on obesity and its late consequences in youngster group. In this paper, we have done comparison of clinical and biochemical parameters of metabolic syndrome to healthy controls with special attention among youngsters for the prevalence of diagnosis and its complications.

2. Material and methods

2.1. Study type and design

This is an Open Label, Single Centered; hospital based random selection comparative study. This study was conducted at Toxicology and Experimental Medicine Division of CSIR-CDRI in collaboration with Department of Medicine, King George's Medical University (KGMU), Lucknow.

The present study was conducted on the indoor and outdoor MS patients and its complications (age categorized as young (18–35 yr), middle (36–55 yr) and old (≥56 years) visited the King George Medical University (KGMU), Lucknow along with their written informed consent. The clinical examination and medical history, anthropometric and demographic profile of patients with past and current medications was recorded and subjects were enrolled in respective as per inclusion/exclusion criteria. The blood samples were collected at the KGMU from 64 patients with healthy control group (Group I), Healthy subjects without any risk factors of metabolic syndrome, 110 with MS group (Group II, according to IDF-International Diabetes Federation Criteria) and 71 with Complicated Group III (such as cerebrovascular accidents, cardiovascular accidents, DN or chronic kidney disease (CKD) and hypertension etc.). The study was duly approved by the local ethics committee and written informed consent was obtained from all patients involved.

2.2. Sample collection and processing

Serum was collected from clotted blood using serum separator tubes centrifuged at 2000 rpm for 10 min at 4 °C. The serum was snap-frozen and stored at −80 °C until required. All serum samples were thawed only once.

2.3. Determination of biochemical measurements

The clinical serum samples were also used to measure fasting Glucose, total protein (TP), albumin (ALB), total bilirubin (TBIL), alanine aminotransferase (ALT or SGPT), aspartate aminotransferase (AST or SGOT), alkaline phosphatase (ALP), Uric acid, Urea, Creatinine, hsCRP, HbA1c and lipid profile. All of the parameters were measured using Fully Automated Clinical Chemistry Analyzer (TRANSASIA Bio-medical Ltd, India, Erba Manheim).

2.4. Statistical analysis

The parameters have been summarized as Mean ± SD, n. The prevalence of MS was compared by *t*-test. With two sided test hypothesis the significance of patients group was marked "*" ($p < 0.05$), "**" ($p < 0.01$) and NS ($p > 0.05$, not significant). In the complicated group, some parameters had missing observations. The sex wise parameters were compared separately.

3. Results and discussion

3.1. Demographic

Total 245 individuals were included in this study. We present an open label, single centered comparative study aimed to evaluate the performance of biochemical parameters in assessing MS and its complications in population.

3.2. Disease wise prevalence

Observations were collected and categorized into three types of patients *viz.* healthy/control, metabolic syndrome and complicated cases of MS. The demographic characteristics (age and gender) of three groups are summarized in Table 1. Out of 245 registered patients in this study there were 148 males (60.4%) and 97 females (39.6%). The stage wise 64 patients were healthy (26.1%) and 110 were MS (44.9%) and 71 were complicated group (29.0%). The proportional distribution of male and female patients was almost same in all the three categories of patients.

3.3. Age wise categorization

Age wise cases comprised of three groups young (18–35 yr, 30.4%), middle (36–55 yr, 61.3%) and old (≥56 years, 8.3%). The age wise categorization of MS was 34.5% young, 71.2% middle and 80% old aged patients respectively. The male subjects of middle age group outnumbered females in visiting OPD of MS and complicated as compared to healthy control.

3.4. Gender wise prevalence

Sex-wise prevalence was 56.6% males and 43.4% females MS cases. The prevalence of majority of MS cases, 71.8% was in the middle age group (Male 40.9%, female 30.9%). Its prevalence among old patients was less than 10% (male 7.3%, female 3.6%). The MS prevalence among young was found in 17.3% cases (male 8.2%, female 9.1%). In this study, the prevalence of MS highest among middle age group. It was associated with BMI, BP (Sys, Diastolic), waist circumference (Central obesity), cholesterol, TG, HDL, LDL, Urea, Creatinine, HbA1c, Glucose fasting and HsCRP parameters. This phenomenon was common among both male and female

Table 1
Demographic characteristics of three groups.

Demographic characteristics	Healthy control group (Group I)	Metabolic syndrome group (Group II)	Complicated group (Group III)
Age (yrs) Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Gender			
Female	29.62 ± 9.40 (n = 21)	43.67 ± 8.95 (n = 48)	43 ± 5.32 (n = 28)
Male	36.08 ± 8.88 (n = 43)	45.34 ± 8.08 (n = 62)	46.12 ± 10.53 (n = 43)
Age Wise Category (years)			
Young (18–35)	26.61 ± 4.94 (n = 35)	31.37 ± 4.25 (n = 19)	29.85 ± 4.90 (n = 13)
Middle (36–55)	42.29 ± 4.87 (n = 28)	45.70 ± 4.76 (n = 79)	45.57 ± 4.05 (n = 49)
Old (56–70)	58 ± 0 (n = 1)	58.42 ± 1.51 (n = 12)	65.25 ± 4.56 (n = 8)

patients.

MS females of young age group outnumbered men proportionally in all the parameters. They were obese, hypertensive, hyperlipidemic, hyperglycemic and with renal disorders. Similar pattern of proportionally higher female than male was recorded in middle age group also. But this pattern reversed in old patients.

3.5. Personal habits

The history of patients was recorded. Not all patients disclosed their personal habits. Of all the individuals disclosed their personal information 31.4% were smokers and 30.2% were tobacco users. Not all smokers were alcoholic but there were 31.4% were its users. Sedentary life style is a general feature these days. Male number was higher than female in all the category of patients by disease or age wise. Their representation was higher may be because of their high age than females or their profession. Jobs in cities are of sitting type mostly. The 12.7% males were in job.

3.6. Anthropometric characteristics

The disease remains uninfluenced with the height of patients. However, a significant increase in the body weight of MS group patients confirms the role of BMI among MS patient the BMI of MS patient was significantly higher than healthy in both the genders ($p < 0.01$) shown in Table 2. The hospitalized complicated patients, BMI was significantly lower in both male and female patients than MS. This could be the effect of severe trauma of stroke or CVD or DN. The complicated patients were admitted cases of hospital. They were under clinical supervision before and after the episode. It might be this reason that their BMI was affected with suitable diet chart as per clinical advice.

The waist size (central obesity) of both male and female were significantly higher in the MS group and complicated group ($p < 0.01$). The average waist size of healthy male and female was 83.3 ± 7.6 cm and 80.4 ± 15.5 cm (Table 2). In this study the waist size of male was higher than female. (Table 2). This increase of waist circumference of male and female in MS and complicated group is also a risk factor and may be due sedentary life style or physical inactivity which fall the individual under MS.

In our study, the mean BP systolic of control was 122.6 ± 9.7 and 115.0 ± 8.2 in male and female respectively (Table 2). However, the MS group patients had significantly raised BP ($p < 0.01$) raised to 140.4 ± 15.3 and 138.0 ± 10.2 in male and female patients respectively. Although, the systolic BP were higher in the complicated group than control yet the increase was significant among female patients only. The pattern of BP diastolic was similar to BP systolic (Table 2). High blood pressure of individual makes the individuals hypertensive and categorized as MS. In our study population the high BP was reported in 9.1% (female) and 6.4% (male) in young group, 36.4% (male) and 27.3% (female) of middle age group, 5.5% (male) and 3.6% (female) in old group population respectively (Fig. 1). Uncontrolled High blood pressure (hypertension) can cause various complications such as Heart complications (CAD, TIA, CKD,

Table 2
Anthropometric characteristics of three groups and their comparison.

Parameters	Sex	Control	MS	Complicated	Con vs MS	Con vs Compl.	MS vs Compl.
Age	M	36.0 ± 9.2,43	45.3 ± 8.1,62	46.1 ± 10.5,43	**	**	NS
	F	29.6 ± 8.9,21	43.7 ± 9.0,48	43.0 ± 9.9,28	**	**	NS
	M + F	33.9 ± 9.5,64	44.6 ± 8.5110	44.9 ± 10.3,71	**	**	NS
Height	M	165.5 ± 8.0,43	165 ± 7.5,62	164.2 ± 5.3,33	NS	NS	NS
	F	153.8 ± 9.2,21	152.8 ± 6.0,48	156.6 ± 10.6,20	NS	NS	NS
	M + F	161.7 ± 10.0,64	159.6 ± 9.2110	161.3 ± 8.5,53	NS	NS	NS
Weight	M	61.4 ± 8.5,43	78.4 ± 10.8,62	62.0 ± 11.3,34	**	NS	**
	F	52.3 ± 8.6,21	72.3 ± 14.0,48	57.5 ± 9.9,20	**	NS	**
	M + F	58.4 ± 9.5,64	75.7 ± 12.6110	60.3 ± 10.9,54	**	NS	**
Waist	M	83.3 ± 7.6,43	102.7 ± 12.4,62	94.1 ± 8.2,19	**	**	*
	F	80.4 ± 15.5,21	102.1 ± 12.7,48	89.7 ± 9.6,7	**	*	**
	M + F	82.4 ± 10.8,64	102.5 ± 12.5110	92.9 ± 8.7,26	**	*	**
Hip	M	88.1 ± 8.6,43	101.7 ± 12.2,62	93.6 ± 5.4,12.0	*	NS	NS
	F	87.8 ± 15.5,21	105.7 ± 13.7, 48	96.0 ± 10.4, 3	**	NS	NS
	M + F	88.0 ± 11.0,64	103.4 ± 13.0,110	94.1 ± 6.3,15	**	*	**
BP-Systolic	M	122.6 ± 9.7,43	140.4 ± 15.3,62	134.0 ± 17.1,43	**	**	NS
	F	115.0 ± 8.2,21	138.0 ± 10.2,48	129.3 ± 10.8,28	**	**	*
	M + F	120.1 ± 9.9,64	139.3 ± 13.3110	132.1 ± 15.0,71	**	**	**
BP-Diastolic	M	78.4 ± 7.5,43	88.9 ± 8.9,62	84.7 ± 6.3,43	**	**	NS
	F	72.5 ± 5.1,21	86.6 ± 9.0,48	82.8 ± 8.2,28	**	**	NS
	M + F	76.5 ± 7.3,64	88.0 ± 9.0,110	83.9 ± 7.1,71	**	**	**
BMI	M	22.1 ± 2.5,43	28.9 ± 4.0,62	22.8 ± 3.8,33	**	NS	**
	F	22.3 ± 4.1,21	30.9 ± 5.7,48	23.8 ± 4.1,19	**	NS	**
	M + F	22.3 ± 3.1,64	29.8 ± 4.9110	23.2 ± 3.9,52	**	NS	**

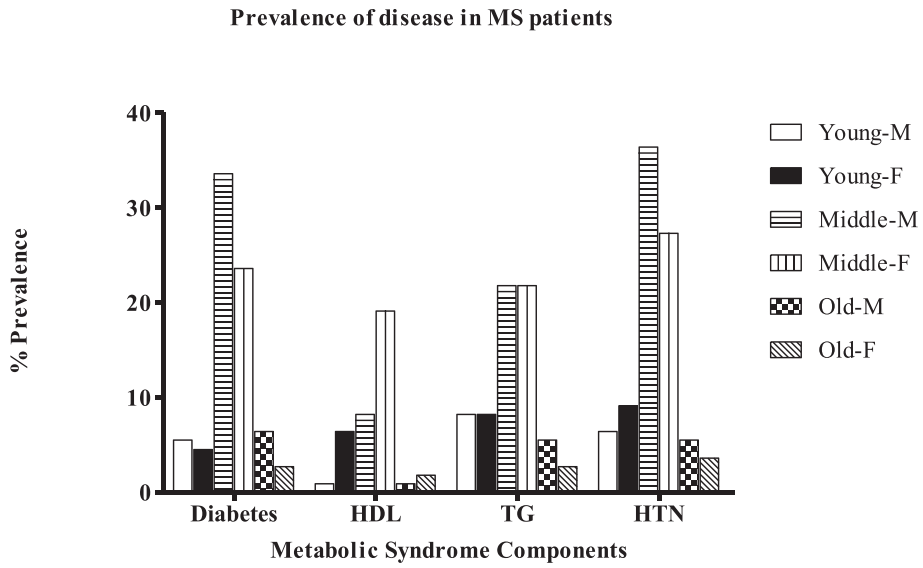

Fig. 1. Prevalence of disease in MS patients.

DN, stroke, MI etc.). In our study we found that stroke is prevalent in young population and CKD or DN is prevalent in middle age group population both in male and female respectively.

3.7. Biochemistry parameters

Chiefly serum glucose, Cholesterol, TG, HDL, LDL, Uric acid, SGOT, SGPT, Bilirubin Total and Direct, ALP, Urea, Creatinine, hsCRP, HbA1c, Total Protein and Albumin parameters were estimated from the blood sample presented in Table 3.

Urea and creatinine are considered to be key indicator of severity of kidney dysfunction. Although urea, creatinine and uric acid of MS patients was uniformly higher in MS than the control group but the difference was not significant ($p > 0.05$). The urea and creatinine of complicated group was significantly ($p < 0.01$) more than the control and MS group. The urea of the complicated group increased in females (190.8%) and in males (147.5%) than the control group. Also, these levels in the complicated patients were more than 100% higher than the MS group. A similar pattern of variation was seen in creatinine also. The change in creatinine of MS patients from control was more in males (180%) than the females (162.5%) than the control group. The creatinine in the males of the complicated group was 133.3% and in female (90.9%) greater than levels in the MS group. The vast changes in urea and creatinine levels lead the patient towards diabetic nephropathy or chronic kidney disease.

Changes in the liver parameters of MS group from control were not significant in ALP, Bil T & D, TP and ALB, SGOT. However, the level of SGPT was significantly greater than control. The TP and ALB among complicated patients were significantly ($p < 0.01$) lower than the control and MS group. This patter was common in both male and female patients. The hsCRP of complicated group increased more than 270% in male and more than 800% in females. Most of the complicated group patients were suffering from cardiac issues including MI, CVA, CVD, CAD, heart attack. However, majority of the patients in complicated group were of stroke.

The complications flare three dimensionally viz., stroke, cardio vascular disorder, DN after MS. It was observed in our sample that kidney is a more sensitive and primarily organ for severe complications as compared to heart and brain age wise.

3.8. Serum glucose

The measured fasting glucose in healthy male and female patients was 82.3 mg/dl, 78.7 mg/dl respectively. The MS group glucose level in both males (169.4 mg/dl) and females (158.1 mg/dl) was significantly higher ($p < 0.01$) than the control group. Although the glucose level of complicated patients was lower than MS group ($p > 0.05$), yet its level was significantly higher than the control in male (133.0 mg/dl) and female (145.4 mg/dl) respectively. The high SD values in MS and complicated group may be due to the undergoing treatments of subjects for diabetes and HTN. We must recall that the samples are from patients visited hospital. This increase of glucose level from healthy to MS makes the patients hyperglycemic or Diabetic or Type 2 Diabetes Mellitus (T2DM) and categorized as MS patient. Prevalence of high glucose was reported 4.5% (female) and 5.5% (male) in young group, 33.6% (male) and 23.6% (female) of middle age group, 0.9% (male) and 1.8% (female) in old group population respectively (Fig. 1). The complication of uncontrolled sugar level causes the MI, CVA, Heart attack. Kidney failure (CKD or DN) or dysfunction.

In addition, high HbA1c ($P < 0.01$) in complicated group than control was found among female. Among males it was not significantly higher. However, the combined sample of male and female showed significantly high ($p < 0.01$) HbA1c values than control group. This may be due to T2DM affects the glucose values which affected HbA1c.

3.9. IDF criteria

Following IDF criteria lipids are known to have significant participation in the metabolic syndrome. The TG levels among MS group was about 100% higher than control group. However, the rate of increase of TG of MS group was 128% in female, 130% in male as shown in Table 3. The TG level of complicated was lower than the MS group ($p < 0.05$). Prevalence of high TG was reported 8.2% (female) and 8.2% (male) in young group, 21.8% (male) and 21.8% (female) of middle age group, 5.5% (male) and 2.7% (female) in old group population respectively (Fig. 1). The elevated level of TG indicates high level of bad cholesterol and low level of good cholesterol in blood and it associated with the risk of stroke or heart problems on further complication. Hypertriglyceridemia with other

Table 3
Biochemical characteristics of different groups with their comparison.

Parameters	Sex	Control	MS	Complicated	Con vs MS	Con vs Compl.	MS vs Compl.
SGOT	M	24.7 ± 6.5,43	32.9 ± 17.4,62	51.3 ± 47.0,30	NS	**	**
	F	22.2 ± 5.3,21	32.0 ± 15.2,48	28.0 ± 19.0,18	NS	NS	NS
	M + F	23.9 ± 6.2,64	32.5 ± 16.4110	42.6 ± 40.3,48	*	**	**
SGPT	M	20.7 ± 11.4,43	37.8 ± 25.3,62	40 ± 41.3,30	*	**	NS
	F	14.8 ± 5.6, 21	31.1 ± 18.1,48	20.1 ± 23.6,18	*	NS	NS
	M + F	18.8 ± 10.2,64	34.9 ± 12.6110	32.5 ± 36.7,48	**	**	NS
ALP	M	79.8 ± 31.1,43	88.5 ± 20.2,62	125.4 ± 118.7,28	NS	*	NS
	F	68.8 ± 11.7,21	95.2 ± 27.5,48	118.0 ± 11.2,18	NS	**	NS
	M + F	76.2 ± 26.8,64	91.4 ± 23.4110	122.5 ± 114.6,46	NS	**	**
Bilirubin T	M	0.9 ± 0.2, 43	0.9 ± 0.3,62	0.8 ± 0.4,27	NS	NS	NS
	F	0.8 ± 0.1,21	0.8 ± 0.3,48	1.0 ± 1.5,18	NS	NS	NS
	M + F	0.9 ± 0.2,64	0.9 ± 0.3110	0.9 ± 1.0,45	NS	NS	NS
TP	M	7.4 ± 0.5,43	7.8 ± 1.1,62	6.3 ± 0.9,30	*	**	**
	F	7.0 ± 0.7,21	7.2 ± 0.9,48	6.3 ± 1.0,18	NS	**	**
	M + F	7.2 ± 0.6,64	7.6 ± 1.1110	6.3 ± 0.9,48	*	**	**
Alb	M	4.2 ± 0.5,43	4.4 ± 1.0,62	3.1 ± 0.8,30	NS	**	**
	F	3.9 ± 0.3,21	4.0 ± 0.8,48	2.9 ± 0.8,18	NS	**	**
	M + F	4.1 ± 0.5,64	4.2 ± 0.9110	3.1 ± 0.8,48	NS	**	**
Chol	M	163.6 ± 30.9,43	188.8 ± 42.9,62	142.9 ± 53.8,30	NS	NS	**
	F	156.6 ± 39.9,21	172.0 ± 49.4,48	140.2 ± 40.3,19	NS	NS	*
	M + F	161.3 ± 34.0,64	181.5 ± 46.4110	141.8 ± 51.6,49	**	*	**
TG	M	104.1 ± 46.7,43	201.3 ± 103.9,62	140.8 ± 81.4,29	**	NS	*
	F	81.1 ± 44.4, 21	184.9 ± 60.9,48	158.9 ± 129.5,19	**	**	NS
	M + F	96.5 ± 46.9,64	194.1 ± 87.8110	148.0 ± 102.2,48	**	**	**
HDL	M	47.9 ± 11.1,43	51.3 ± 14.2,62	35.2 ± 15.9,27	NS	**	**
	F	47.9 ± 14.4, 21	45.7 ± 12.8, 48	35.5 ± 22.9, 17	NS	**	**
	M + F	47.9 ± 12.2,64	48.9 ± 13.8110	35.3 ± 18.7,44	NS	**	**
LDL	M	93.1 ± 26.4, 43	116.4 ± 30.5,62	65.7 ± 48.3,26	*	**	**
	F	87.4 ± 29.2,21	110.9 ± 33.5,48	74.0 ± 33.1, 18	*	NS	**
	M + F	91.2 ± 27.2, 64	114.0 ± 31.8, 110	69.1 ± 42.5,44	**	**	**
Urea	M	23.6 ± 6.9,43	28.5 ± 17.0,62	58.4 ± 44.7,30	NS	**	**
	F	19.6 ± 5.6,21	26.7 ± 10.8,48	57.0 ± 35.5,20	NS	**	**
	M + F	22.3 ± 6.7,64	27.7 ± 14.4110	57.8 ± 40.9,50	NS	**	**
Creatinine	M	1.0 ± 0.2,43	1.2 ± 0.4,62	2.8 ± 3.7,30	NS	**	**
	F	0.8 ± 0.1,21	1.1 ± 0.6,48	2.1 ± 1.8,20	NS	**	*
	M + F	1.0 ± 0.2,64	1.2 ± 0.5110	2.6 ± 3.1,50	NS	**	**
Uric Acid	M	5.4 ± 1.9,43	5.6 ± 2.2,62	5.4 ± 2.6,37	NS	NS	NS
	F	4.0 ± 1.3,21	5.3 ± 2.7,48	5.8 ± 2.7,28	*	*	NS
	M + F	5.0 ± 1.9,64	5.5 ± 2.4110	5.6 ± 2.7,65	NS	NS	NS
Glu-F	M	82.3 ± 15.0,43	169.4 ± 88.8,62	133.0 ± 74.1,42	**	**	NS
	F	78.7 ± 10.4, 21	158.1 ± 78.5,48	145.4 ± 75.8,28	**	**	NS
	M + F	81.1 ± 13.7,64	164.5 ± 84.3110	138.0 ± 74.5,70	**	**	*
HsCrp	M	1.0 ± 1.3,43	1.2 ± 2.0,62	4.4 ± 7.4,42	NS	NS	NS
	F	0.9 ± 0.8,21	1.0 ± 0.8,48	9.1 ± 25.0,28	NS	**	**
	M + F	0.9 ± 1.2,64	1.1 ± 1.6110	6.3 ± 16.8,70	NS	**	**
HbA1c	M	6.4 ± 1.7,43	8.0 ± 3.4,62	7.8 ± 2.5, 41	NS	NS	NS
	F	5.5 ± 1.0,21	6.8 ± 2.1,48	7.6 ± 2.2, 27	NS	**	NS
	M + F	6.1 ± 1.6,64	7.4 ± 3.0,110	7.7 ± 2.4,68	**	**	NS

Con: Control.
MS: Metabolic Syndrome.
Cmp: Complicated.

components of MS like obesity, HTN, diabetes is very critical makes them MS. Elevated levels of triglycerides are associated with atherosclerosis, even in the absence of hypercholesterolemia (high cholesterol levels), and predispose to cardiovascular disease. Lipid abnormality is one of the causes of MS.

Mean changes in HDL cholesterol in both sex were not significant ($p > 0.05$) in the MS group from control. It could be due to the natural behavior that the hospital visiting patients do not have much variation in the HDL cholesterol. However, HDL cholesterol in MS group male was 51.3 mg/dl and female was 45.7 mg/dl. The variation was not significantly different ($p > 0.05$).

Significant changes ($p < 0.05$) in cholesterol were found in the combined sample of male and female. The LDL between control and MS group of male and female were significantly different ($p < 0.05$). The complicated group show lower LDL cholesterol ($p < 0.01$) than the MS group. It could be attributed to the treatment for lipid abnormality, taken by previously diagnosed patients. LDL stands for Low-Density Lipoproteins whenever LDL level is high, it can start to form a plaque-like substance on the walls of your cardiovascular system, blocking the natural flow of blood and leaving you at severe risk for heart attack and stroke. But simply, LDL is the bad kind of cholesterol in your blood.

The lipid level of the complicated group was lower than the MS patients in both male and female patients. The cholesterol (12.5%), TG (101.1%), LDL (25%) and HDL (2.1%) levels of male was higher in the MS group than control healthy group (Table 3). The unexpected values of lipids in the complicated group could be attributed to the blood samples of indoor patients under clinicians' supervision.

Considering waist circumference (central obesity), 88.7% of male and 97.9% female were centrally obese. The rate of elevated blood

pressure was similar sex wise male (69.4%) and female (62.5%) were diagnosed hypertensive. In addition to this, male (80.6%) and female (70.8%) were type 2 diabetic. The TG (>150) was prevalent high among females (75.0%) than males (62.9%). Rate of low HDL was prevalent more among females (62.5%) as compared to male (17.7%) showing lipid abnormality. Age wise (young, middle age and old age group) prevalence of population of MS, HTN and lipid abnormality was presented in Fig. 1. Central obesity or waist circumference, high blood pressure, high glucose level, high TG level, low HDL is basic components of MS. In our study all are contributed to makes the individuals MS.

3.10. Prevalence of stroke, DN and cardiovascular problems in complicated group

Patients who were hospitalized due to severe illness, stroke or heart attack were 17.6% young and 70.2% middle aged and 12.2% old. Prevalence of stroke was highest among young patients (14.6%) Prevalence of CKD or DN was leading cause (32.5%) of hospitalization among middle and old category of patients. There was single case of stroke among old patients which was female. Diabetes was a common cause in majority then heart and it is ranked third among complicated patients dominate by female (13.1%) than male. Irrespective of sex, the prevalence of disease in young population was Stroke > CKD/DN > Heart > Others. In the middle age and old CKD > Heart > Stroke > Others (Fig. 2). It means that diabetes and HTN not only affect heart, kidney, brain but other organs too.

The phenomena of high TG, low HDL, high BP and high fasting glucose in the younger population possibly lead to diagnosis of diabetes, hypertension and lipid abnormality. Due to changing physiology between 32 and 35yrs of age helps these individuals to move to metabolic syndrome easily. The presence of metabolic syndrome conditions for a long time helps in the occurrence of complicated conditions like Stroke, DN and cardiovascular problems.

4. Discussion

WHO has given need for a population specific modification of anthropometric measures for the development of MS [17]. As reported, Asian Indians have a high chance of MS and CAD [18]. They have a smaller build and excess body fat with predominant abdominal adiposity with distinct clinical features and metabolic predisposition. Ethnic variations in clinical measures and disease outcome in different population are present [19]. In the wake of population specific, cutoff for waist circumference by IDF depend upon Chinese, Maley and Asian. Indian Population presently we study prevalence on MS North Indian population following IDF [7].

Significant role of higher BMI of MS group was detected in our study with female we won greater than males [17] proposed that waist circumference and BMI may be better predictions of MS in Asians Indians. Investigations of the present study suggest preventing and retarding the progression of MS complications with opportunities of lifestyle modification, weight loss and dietary changes. Khoo et al. (20) mentions that prevalence of MS increased with BMI in both sexes. Kanjilal et al. [17] mention about concentration between waist circumference and BMI for better predictions of MS.

The growing affluence, western lifestyle and diet in the country are pushing prevalence rates of MS progressively higher with incidence of CVDs & diabetes in younger. Indians, it has deeper implications for future healthcare costs and challenging management. Our results detected about 34% youngsters having MS. In this paper young male more than females were diagnosed with MS. The complications from stroke are more than DN or CKD health issues.

The IDF criteria components have shown interesting figures forms in this paper. 16.4% young population has prevalence of high TG. Elevated TG level means high risk of stroke and heart problems which is mostly accompanied with obesity. It was found that in our study. This phenomenon is common as reported with reduced HDL, elevated BP, and fasting glucose [20]. High TG (Triglyceridaemia or lipid abnormality) and high blood pressure (HTN) is prevalent in our young population which is further enhanced the severity of disease which is a leading cause of death and disability in our country [21] Highest incidence of CKD in middle age patients may be the result of frequent cases diabetes, high TG and HTN among youngsters.

Central obesity, high serum glucose, high BP (systolic, diastolic), high lipid (TG, cholesterol) were the high risk factors to develop MS. The present study indicates a strong association between obesity,

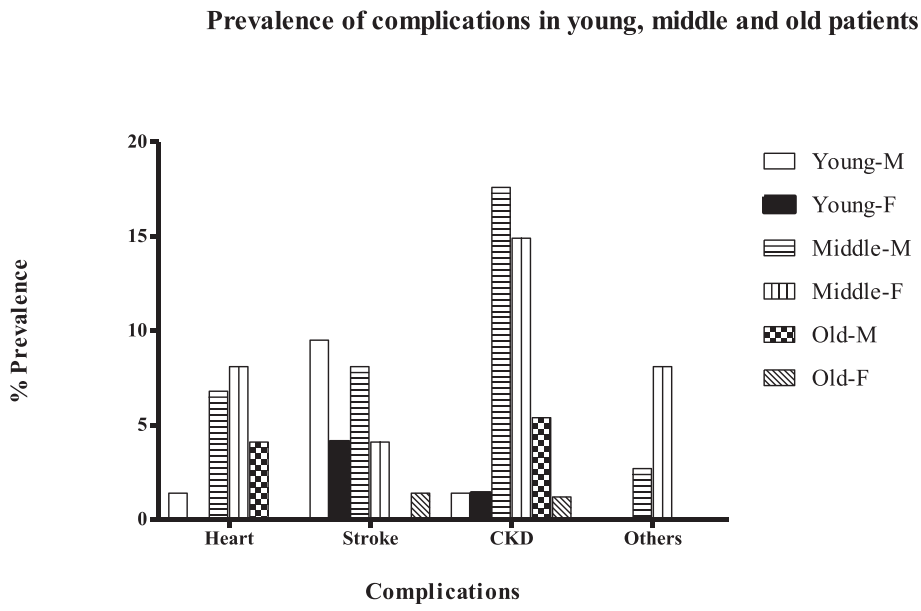

Fig. 2. Prevalence of complications in young, middle and old age patients.

metabolic syndrome, and complicated disease of an early age less than 35 years.

5. Conclusion

MS was prevalent in fair number in young-middle age group. The prevalence of MS in females was higher than males. The prevalence of common MS features among stroke, CVD and CKD in complicated patients is suggestive of special attention on young population to prevent future risk. We also recommend for the comprehensive screening for IDF parameters so that the progression of increased risk of developing MS, T2DM, HTN, CKD and heart problems through dietary and/or life style interventions.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dsx.2019.07.031.

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