



ISSN: 0976-3031

Available Online at <http://www.recentscientific.com>

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 8, Issue, 3, pp. 16256-16260, March, 2017

International Journal of
Recent Scientific
Research

DOI: 10.24327/IJRSR

Research Article

PREVALENCE OF METABOLIC SYNDROME AND ITS ASSOCIATION WITH VARIOUS RISK FACTORS

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DOI: <http://dx.doi.org/10.24327/ijrsr.2017.0803.0113>

ARTICLE INFO

Article History:

Received 17th December,
2016 Received in revised form
21st January, 2017
Accepted 05th February, 2017
Published online 28th March, 2017

Key Words:

Metabolic Syndrome, Diabetes Mellitus,
Dyslipidemia, Hypertension

ABSTRACT

Introduction: Metabolic syndrome (MetS) is regarded as a constellation of the altered metabolic profile. It is considered as pro-atherogenic as the adipose tissues are metabolically active to secrete non-esterified fatty acids initiating atherogenic changes. Active adipocytes also secrete pro-inflammatory mediators and bring about inflammatory changes in various tissues. Being a potent contributor towards cardiovascular disease, it's a disorder of major concern in public health domain. **Objective:** The aim of this study was to analyze the prevalence of MetS in the study population and its association with different variables.

Materials and Methods: The study was conducted during a camp organized by our institute. 246 adult individuals were enrolled for the camp. Following the informed consent, all demographic profile, serum lipid profile and fasting plasma glucose (FPG) were measured. The study population was categorized into three groups: (i) Non-MS group: those who did not meet the criteria for central obesity, (ii) High risk group: those who had central obesity but did not full fill the other two criteria for MetS and (iii) MS group: those who full filled the criteria for MetS as new International Diabetes Federation (IDF) definition.

Results: The prevalence of metabolic syndrome in this area was observed to be 20.7%. The study reflected significant association with age ($p=0.001$), gender ($p<0.001$), waist circumference ($p<0.001$), BMI ($p<0.001$), hypertension ($p<0.001$), FPG ($p<0.001$) and dyslipidemia ($p<0.05$). Hypertension has been significantly associated with MetS and found to significantly reduce the risk of developing MetS in subjects with normal BP (OR=0.17, CI:0.06-0.45).

Conclusion: The study revealed prevalence of MetS to be 20.7% in the study population and outlined the risk factors associated with it. This study would aid in formulating strategies for lifestyle modification, behavioral therapy, diet education and nutritional therapy.

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INTRODUCTION

For years medicine has evidenced significant link between metabolic syndrome (MetS) with central obesity, hypertension, dyslipidemia, insulin resistance (IR) and diabetes mellitus (DM). (Després and Lemieux 2006) Metabolic syndrome is regarded as a constellation of the altered metabolic profile. The new International Diabetes Federation (IDF) definition of metabolic syndrome is that they must have central obesity with any two of the four factors: (i) raised triglyceride (TGL) level, (ii) reduced high density lipoprotein (HDL) levels, (iii) raised blood pressure (BP) and (iv) raised fasting plasma glucose (FPG). (Siddiqui and Gaikwad 2017) It is considered as pro-atherogenic as the adipose tissues are metabolically active to secrete non-esterified fatty acids initiating atherogenic changes. Active adipocytes also secrete pro-inflammatory mediators and

bring about inflammatory changes in various tissues. In 20% cases of MetS have also been associated with diabetes mellitus owing to beta-cell dysfunction due to inflammation. (Vega 2004) It is regarded as a potent contributor for cardiovascular disease (CVD) and hence of major public health concern. (Bays *et al.* 2008) Global prevalence of MetS ranges from <10% to 84% depending on the geographical, cultural and demographical (age, sex, ethnicity, social status, physical status of obesity) distribution in different regions of the world. Hence, there must be a proper understanding of the distribution of the syndrome in a particular geographical area. During a camp organized by our institute for screening for diabetes mellitus, we evidenced for a good number of cases of MetS. Hence, the aim of this study was to analyze the prevalence of MetS in the study population and its association with different variables.

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MATERIALS AND METHODS

The study was conducted during a camp organized by our institute after its approval by the Institutional Research Cell. Individuals were called for screening for diabetes mellitus and preparatory information were circulated in the area inscribed in leaflets, written both in English and in local language, a week before. All laboratory analyses were performed in our laboratory free of cost. 246 adult individuals were enrolled for the camp. Following the informed consent, the demographic profiles demographic profile were measured. Blood was collected for serum lipid profile and FPG.

Diagnostic criteria for MetS were followed as per new IDF definition:(Siddiqui and Gaikwad 2017)

Individuals must have

- Central obesity: waist circumference (WC) in men \geq 94cm and women \geq 80cm.
- Associated with any two of the following factors:
 1. Elevated TGL - \geq 150 mg/dl
 2. Reduced HDL cholesterol - $<$ 40 mg/dl in males and $<$ 50 mg/dl in females
 3. Raised BP – systolic \geq 130 and Diastolic \geq 85 mm of Hg
 4. Raised FPG - \geq 100 mg/dl
 5. All hyperglycemics were subcategorized as pre-diabetic and diabetic as per the diagnostic criteria laid by American Diabetes Association (ADA,REYNOLDS 2017)
 6. Diabetics: Individuals with FPG \geq 126 mg/dl and/or HbA1c \geq 6.5%. If any patient has A1c \geq 6.5% but FPG $<$ 126 mg/dl, that person was considered as diabetic.
 7. Pre-diabetics: Individuals with FPG between 101 - 125 mg/dl and/or HbA1c =5.7 – 6.4%.

The study population was categorized into three groups

1. Non-MS group: those who did not meet the criteria for central obesity
2. High risk group: those who had central obesity but did not full fill the other two criteria for MetS
3. MS group: those who full filled the criteria for MetS as per new IDF definition

Statistical analysis was performed using IBM SPSS version 16.0. Causal association between the variables was determined by Chi-Square (χ^2) test. Logistic regression analysis was used to evaluate the strength of association and to find the odds ratio to predict the likely risk factors for metabolic syndrome. For two tailed p-values of $<$ 0.05 was considered significant, with 95% confidence intervals.

RESULTS

The prevalence of metabolic syndrome in this area was observed to be 20.7% (n=51/246) whereas the prevalence of high risk for MS (subjects having central obesity as per waist circumference) was 33.7% (n=83/246). The observed prevalence of MetS according to study variables have been shown in table-1. The prevalence documented increasing trend with age. Highest prevalence of MetS was observed in hypertensive subjects (58%) followed by diabetic cases (50%).

Table 1 The observed prevalence of MetS according to the study variables

Variables	Prevalence of MS	
Age (years)	\leq 30, n=67	10%
	31-40, n=76	14%
	41-50, n=72	31%
	51-60, n=27	30%
	$>$ 60, n=4	75%
Gender	Male n=173	20%
	Female n=73	23%
BMI	High, n=152	32%
Hypertension	Present, n=26	58%
	FPG	Pre-diabetes, n=39
	Diabetes, n=30	50%
Dyslipidemia	Present, n=176	22%

The mean values of the variables in the study population have been illustrated in figure-1. The mean age group was significantly higher for MS group compared to other two (p $<$ 0.001).

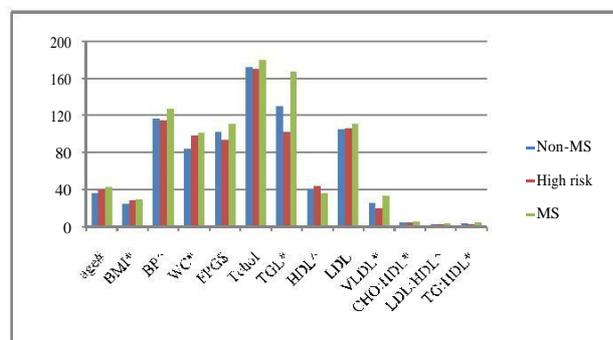


Figure 1 Comparison of mean values of the variables in the study population

#significant difference in MS group as compared to non-MS and high risk group
 *significant different among all the three groups
 ^significant difference in MS and high risk group as compared to non-MS group
 §significant difference in MS group as compared to high risk group

Table 2 Distribution and association of variables to the demographic and biochemical profile

Variables		Non-MS (112)	High risk (83)	MS (n=51)	P
Age (years)	\leq 30, n=67 (27.2%)	44	16	7	0.001
	31-40, n=76 (30.9%)	34	31	11	
	41-50, n=72 (29.3%)	25	25	22	
	51-60, n=27 (11%)	9	10	8	
	$>$ 60, n=4 (1.6%)	0	1	3	
Gender	Male n=173 (70.3%)	103	36	34	$<$ 0.001
	Female n=73 (29.7%)	9	47	17	
Exercise	Yes, n=121 (49.2%)	55	39	27	0.8
	No, n=125 (50.8%)	57	44	24	
Addiction	Yes, n=64 (26%)	37	15	12	0.06
	No, n=182 (74%)	75	68	39	
BMI	Normal, n=94 (38.2%)	71	20	3	$<$ 0.001
	High, n=152 (61.8%)	41	63	48	
Waist circumference	Normal, n=111 (45.1%)	110	0	0	$<$ 0.001
	High, n=135 (54.9%)	2	83	51	
Hypertension	Present, n=26 (10.5%)	7	4	15	$<$ 0.001
	Absent, n=220 (89.4%)	105	79	36	
FPG	Normal, n=177 (71.9%)	87	69	12	$<$ 0.001
	Pre-diabetes, n=39 (15.8%)	13	11	15	
	Diabetes, n=30 (12.2%)	12	3	15	
Dyslipidemia	Present, n=176 (71.5%)	71	67	38	0.03
	Absent, n=70 (28.5%)	41	16	13	

Similarly BMI, WC, TGL, VLDL, CHO: HDL and TG:HDL were also significantly different in the three groups. Both MS and high risk subjects had significantly higher BP compared to non-MS individuals ($p < 0.001$). FPG was significantly higher in MS population as compared to non-MS subjects. The distribution of variables in both the groups is depicted in table-2.

The distribution of variables in both the groups is depicted in table-2. Chi-square study reflected significant association with age ($p = 0.001$), gender ($p < 0.001$), waist circumference ($p < 0.001$), BMI ($p < 0.001$), hypertension ($p < 0.001$), FPG ($p < 0.001$) and dyslipidemia ($p < 0.05$) (table-2). The strength of association was calculated by multinomial logistic regression analysis and has been documented in table-3.

Table 3 Strength of association of different variables for predicting the risk of metabolic syndrome in the study population

			Coefficient	p	OR	CI
High risk	Gender	Female	2.89	<0.001	18	7.7 – 42.31
		Male	0			
	BMI	Normal	0	0.33	3.73	0.27-52.33
		High	1.32			
	Hypertension	Present	0	0.58	1.4	0.4-5.1
		Absent	0.36			
	FPG	Normal	1.15	0.08	3.17	0.86-11.68
		Pre-diabetes	1.22	0.11	3.38	0.75-15.14
	Dyslipidemia	Diabetes	0			
		Absent	-1.28	0.002	0.28	0.13 -0.62
MS	Gender	Female	1.87	<0.001	6.4	2.58 – 16.16
		Male	0			
	BMI	Normal	0	0.04	19.1	1.18-37.9
		High	2.95			
	Hypertension	Present	0			
		Absent	-1.79	<0.001	0.17	0.06-0.45
	FPG	Normal	-1.64	<0.001	0.19	0.08-0.47
		Pre-diabetes	-0.08	0.88	0.92	0.32-2.7
	Dyslipidemia	Diabetes	0			
		Absent	-0.73	0.07	0.48	0.22 – 1.05
		Present	0			

Odds in female population is 18 times that of males to fall in high risk group as compared to non-MS group (CI:7.7-42.31; $p < 0.001$). The likelihood developing MS in females was 6.4 times that of males (CI:2.58-16.16; $p < 0.001$). Subjects with raised BMI were found to be 19.1 times more likely to develop MS against non-MS population (1.18-37.9; $p = 0.04$). Absence of dyslipidemia was found to reduce the chances of high risk when compared against the non-MS subjects (OR=0.28; CI:0.13-0.62; $p = 0.002$). The risk of developing MS in individuals with normal BP and FPG was observed to be low as compared to non-MS population (OR=0.17;CI:0.06-0.45 and OR=0.19; CI:0.08-0.47, $p < 0.001$ respectively).

DISCUSSION

The overall prevalence of MetS in the study group was 20.7% which was found to be within the world wide prevalence range of 10 -84%. (Kolovou *et al.* 2007) The prevalence depicted a rising trend after the age of 40 years and the mean age was significantly ($p < 0.01$) higher in MS group as compared to other two groups. The observation was quite similar to the study by Ford *et al* who published prevalence of 6.7 % among the age group of 20-29 years, 20% in individuals aged 40-49 and 45% in those above 60 years.(Ford, Giles, and Dietz 2002) During the National Health and Nutrition Examination survey

(NHANES), Park *et al* evidenced for prevalence of 5% in individuals with normal weight, 22% to 60% in overweight and obese cases.(Park *et al.* 2003) We too recorded prevalence of 3% and 32% respectively in normal and overweight subjects. The BMI increased significantly in the three groups from non-MS to high risk to MS group. The prevalence of MetS in male (20%) and females (23%) observed in our study also found to be within the range 8-43% in men and 7-56% in women, published by Cameron *et al.* (Cameron, Shaw, and Zimmet 2004) Female population revealed higher prevalence of central obesity (88%) as compared to males (40%) that reflects the significant association ($p < 0.001$) of gender with high risk and MS group in this study. Various other studies also reproduced high prevalence among postmenopausal females. (Jouyandeh *et al.* 2013; Pradhan 2014; Rochlani, Pothineni, and Mehta 2015) Logistic analysis depicted that females are 18 times more likely to develop MetS as compared to non-MS group. This might be due to the fact that most of them were housewives and leading a sedentary lifestyle. Besides, imbalance in estrogen receptors- α and $-\beta$ ratio, especially in postmenopausal women, has been accounted for the altered metabolic profile in them (Barros and Gustafsson 2011).

Prevalence of MetS among pre-diabetics and diabetics was found to be 38% and 50% respectively. FPG was found to be significantly higher in MS individuals when compared to high risk cases. Nsiah *et al* in their study reported prevalence of 58% in type-2 DM and 60% as hypertensive.(Nsiah *et al.* 2015) Adipose tissue deposition curtails blood supply to the adipocytes generating hypoxic environment and initiates necrosis and macrophage infiltration. These changes stimulate release of pro-inflammatory mediators like tumor necrosis factor (TNF)- α , interleukin-6 (IL-6), plasminogen activator inhibitor-1 (PAI-1) and C-reactive protein (CRP) that initiate inflammatory changes in pancreatic β -cells and also promotes resistance of adipocytes and skeletal muscles to insulin by inhibiting receptor signaling.(Lau *et al.* 2005; Hotamisligil *et al.* 1996; Deepa *et al.* 2006) Absence of dyslipidemia attributed reduced risk of MetS as compared to the non-MS population. The pro-inflammatory mediators like TNF- α , IL-6 and PAI-1 have been evidenced for their positive correlation with BMI, WC, triglyceridemia and low HDL cholesterol levels and hence induce atherogenesis.(Xydakis *et al.* 2004) Dyslipidemia also was found to be high in our study population (71.5%). In them, prevalence of MetS was found to be 22%. Calmon *et al* also have highlighted age-adjusted prevalence of MetS and dyslipidemia to be 31.2% and 24.1% respectively.(Flores *et al.* 2005).

Hypertension was ascribed the most common component of MetS (58%) and recorded significantly higher values in MS and high risk groups as compared to non-MS subjects in our study. Hypertension has been significantly associated with MetS and found to significantly reduce the risk of developing MetS in subjects with normal BP (OR=0.17,CI:0.06-0.45). This could be attributed to the active renin angiotensin system (RAS) subjected to insulin resistance and chronic hyperglycemia. (Malhotra *et al.* 2001) Great number of clinical studies have evidenced for the link between insulin resistance and hypertension. About 50% of hypertensive subjects have hyperinsulinemia or or impaired glucose tolerance and 80% of patients of type-II diabetes have hypertension. (Zhou, Wang,

and Yu 2014; Bruder-Nascimento, da Silva, and Tostes 2014) Insulin has been known to induce vasodilatation by stimulating nitric oxide in endothelium and regulates sodium homeostasis by enhancing renal sodium resorption. Active secretion of aldosterone by RAS impairs insulin receptor signaling cascade. (Horita *et al.* 2011; Brands and Manhiani 2012).

The major limitation of our study was that of being a cross-sectional study consisting of a small sample size, hence the results cannot be generalized to the whole population of the state. Large scale cohort studies are required to confirm the observations and initiate preventive actions.

CONCLUSION

The study revealed a higher prevalence of MetS in the study population and outlined the risk factors associated with it. This study would aid in formulating strategies for early diagnosis through effective screening programs for obesity, hypertension, altered lipid profile and glucose intolerance. Knowledge in understanding the risk factors for metabolic syndrome can help formulating preventive and therapeutic strategies like lifestyle modification, behavioral therapy, diet education and nutritional therapy and upgrading the overall health of the people.

Acknowledgements

We are thankful to all the technical and non-technical staff of our department for organizing the camp. We are very much grateful to the Admin and Finance sections of this institute for providing the financial support.

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How to cite this article:

Suprava Patel., Rachita Nanda and Eli Mohapatra.2017, Prevalence of Metabolic Syndrome and Its Association With Various Risk Factors. *Int J Recent Sci Res.* 8(3), pp. 16256-16260. DOI: <http://dx.doi.org/10.24327/ijrsr.2017.0803.0113>
