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ORIGINAL RESEARCH
ОРИГИНАЛЬНОЕ ИССЛЕДОВАНИЕ

Blood pressure status in patients with metabolic syndrome

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Abstract. *Relevance*. Metabolic syndrome (MetS) is existence of many abnormalities, such as abdominal obesity, hypertension, dyslipidemia, and glucose intolerance. The occurrence of MetS in hypertensive people is linked to poorly managed hypertension. One of the parameters for the diagnosis of the syndrome is the presence of increased blood pressure; nevertheless, research shows that MetS patients are likely to experience hypertension often. *Materials and Methods*. 300 metabolic subjects were selected from the medicine OPD as study participants based on the joint interim statement's 2009 definition of the metabolic syndrome. They were divided into three groups (normotensive, pre-hypertensive, and hypertensive) based on blood pressure readings that met the American Heart Association's (AHA) Asian blood pressure criteria. The following parameters were recorded for data collection: anthropometric (Weight, Height, Body Mass Index Waist Hip Ratio), Blood pressure, biochemical (Fasting blood glucose, Lipid profile parameters). *Results and Discussion*. According to the resting blood pressure readings, out of 300 metabolic syndrome participants, 37 were normotensive [male (40.54 %); female (59.45 %)], 115 were pre-hypertensive [male (58.26 %); female (41.74 %), and 148 were hypertensive [male (52.7 %); female (47.3 %)]. In several parameters, there was no such significant difference between male and female participants across all groups. However, the levels of blood total cholesterol, triglycerides, and low-density lipoprotein were considerably greater in hypertensive and pre-hypertensive metabolic participants than in normotensive subjects, while the levels of high-density lipoprotein were lower. *Conclusion*. Study findings suggest, hypertension and pre-hypertension were more prevalent in the group with metabolic syndrome. Additionally, hypertensives have a higher chance of manifesting dyslipidemia.

Keywords: blood pressure, hypertension, metabolic syndrome, pre-hypertension, risk factors

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Ethics approval. Prior to starting the study RUHS College of Medical Jaipur institutional ethical committee clearance was taken.

Consent for publication: Written consent was obtained from the patients for the investigation and publication of relevant medical information according to WMA Declaration of Helsinki — Ethical Principles for Medical Research Involving Human Subjects, 2013.

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Introduction

Metabolic syndrome (MetS) is a cluster of several disorders, which together raise the risk of an individual developing atherosclerotic cardiovascular disease, insulin resistance, and diabetes mellitus, and vascular and neurological complications such as a cerebrovascular accident. MetS is a much larger problem among south Asian populations, including India, has incited plenty of interest over the past 3 decades [1]. There is an escalating age-related prevalence in both men and women [2]. In an international study which had estimated that approximately 13–15 % of the adult population in India is having MetS, with females being more affected (approximately 8–9 % among adult males and 18–19 % among adult females) [3]. Metabolic syndrome (MetS) is characterized by the simultaneous presence of specific abnormalities, including abdominal obesity, hypertension, dyslipidemia and glucose intolerance, leading to increased risk for cardiovascular events. Person having metabolic syndrome had to have three or more of the following cardiometabolic risk factors to meet the diagnosis of MetS as defined by joint interim statement, 2009 [4]:

I. Waist circumference more than 40 inches in men and 35 inches in women.
II. Elevated triglycerides 150 milligrams per deciliter of blood (mg/dL) or greater.
III. Reduced high-density lipoprotein cholesterol (HDL) less than 40 mg/dL in men or less than 50 mg/dL in women.
IV. Elevated fasting glucose of l00 mg/dL or greater.
V. Blood pressure values of systolic 130 mmHg or higher and/or diastolic 85 mmHg or higher.

Metabolic syndrome is associated with development of cardiovascular disease. It is associated with four-fold increase in risk of fatal coronary heart disease and two-fold greater risk of cardiovascular disease and all causes of mortality among men; even after adjusting for age, LDL–C, diabetes, smoking and family history of coronary heart disease (CHD). It is also an important predictor of type 2 diabetes. Patients with MS have 5 to 9-fold increase risk of developing type 2 diabetes [5]. In hypertensive individuals, the presence of MetS is associated with poorly controlled hypertension [6]. The presence of elevated blood pressure is one of the required criteria for the diagnosis of the syndrome, while evidence suggests that hypertension is encountered very often in people with MetS [7].Insulin resistance activates the sympathetic nervous system, upregulates angiotensin II receptors and reduces the synthesis of nitric oxide, leading to increases in heart rate and blood pressure [8, 9].

Materials and Methods

Design of the study

The present observational study was conducted in the Physiology Department of the RUHS College of Medical Sciences and associated hospital, Jaipur. The RUHS College of Medical Sciences, Jaipur, institutional

ethics committee granted the study its ethical approval. The study's estimated sample size was 282, with a margin of error of +/-10 %, a sample percentage of 50 %, and a confidence level of 95 %. The sample size of the study was 300 individuals due to dropouts or non-responding subjects [10]. After analyzing the inclusion and exclusion criteria, all subjects were recruited from the RDBP Jaipuria hospital's medicine OPD, and a written informed consent was acquired from each participant.

In accordance with the Joint Interim Statement from 2009, subjects were diagnosed with metabolic syndrome if they exhibited three or more of the following cardio-metabolic risk factors [1].

(1) Waist circumference more than 40 inches in men and 35 inches in women.
(2) Triglycerides (TG) >150mg/dL.
(3) Reduced HDL–C <40mg/dL in males; <50 mg/dL in females.
(4) Elevated systolic blood pressure (SBP) >130 and/or diastolic blood pressure (DBP) >85mmHg.
(5) Elevated fasting plasma glucose (FPG) >100 mg/dL) between 18–60 years age group of either sex.

The study excluded patients with cardiac conditions (myocardial ischemia, cardiomyopathy, and atherosclerosis), respiratory, musculoskeletal, and renal problems, as well as pregnant and lactating women. Additionally, those with significant impairments including kyphosis, scoliosis, and osteoarthritis were also disqualified, as were those with a recent history of hospitalization within the past three months.

In accordance with the NHANES recommendations, the height (cm) and weight (kg) were measured using stadiometers and calibrated weighing scales, respectively [11].The formula weight (kg)/ height (m^2) was used to determine BMI. Using a linen measuring tape, the circumferences of the waist and hips were measured while the subjects were standing with their heels together, at the level of the umbilicus and the maximal protrusion of the hip, respectively [11]. Following a 15–30 minute period of sitting still, the Sphygmomanometer will be used to measure both SBP and DBP [12].All research subjects had their biochemical data (fasting blood glucose, total cholesterol, LDL, VLDL, triglyceride, and HDL cholesterol levels)gathered [13–15]. For the biochemical testing, they were instructed to arrive after an overnight fast of 8 to 10 hours. We separated these individuals into three groups (normal, pre-hypertensive, and hypertensive) based on their blood pressure (mmHg) readings and the criteria established by the American Heart Association (AHA) for Asians [16].

Statistical analysis

Microsoft Excel was used to organize the collected data. For data that was normally distributed, mean ± SD was computed. Using SPSS software, an unpaired student t-test was used to determine the level of statistical significance. Differences were considered statistically significant when $p < 0.05$.

Results and Discussion

We grouped 300 metabolic syndrome subjects into normotensive (37) [male (40.54 %); female (59.45 %)], pre-hypertensive (115) [male (58.26 %); female (41.74 %)], hypertensive (148) [male (52.7 %); female (47.3 %)] according to their resting blood pressure values (Fig. 1).

Figure 2 depicts the distribution of total metabolic syndrome population on the basis of their inclusion criteria for metabolic syndrome. There were 95.71 % females had waist circumference more 35 inches and 31.25 % males had waist circumference more than 35 inches. There were 77.86 % females had triglyceride level equal to or more than 150 mg/dl and 76.87 % males had triglyceride level equal to or more than 150 mg/dl. There were 84.28 % females had HDL level less than 50 mg/dl and 60 % males had HDL level less than 40 mg/dl. There were 77.86 % females had fasting blood glucose (FBG) level equal to and more than 100 mg/dl and 71.25 % males had fasting blood glucose (FBG) level equal to and more than 100 mg/dl. There were 72.86 % females had systolic blood pressure equal to and more than 130 mmHg and/or diastolic blood pressure equal to and more than 85 mmHg. But 81.25 % females had systolic blood pressure equal to and more than 130 mmHg and/or diastolic blood pressure equal to and more than 85 mmHg.

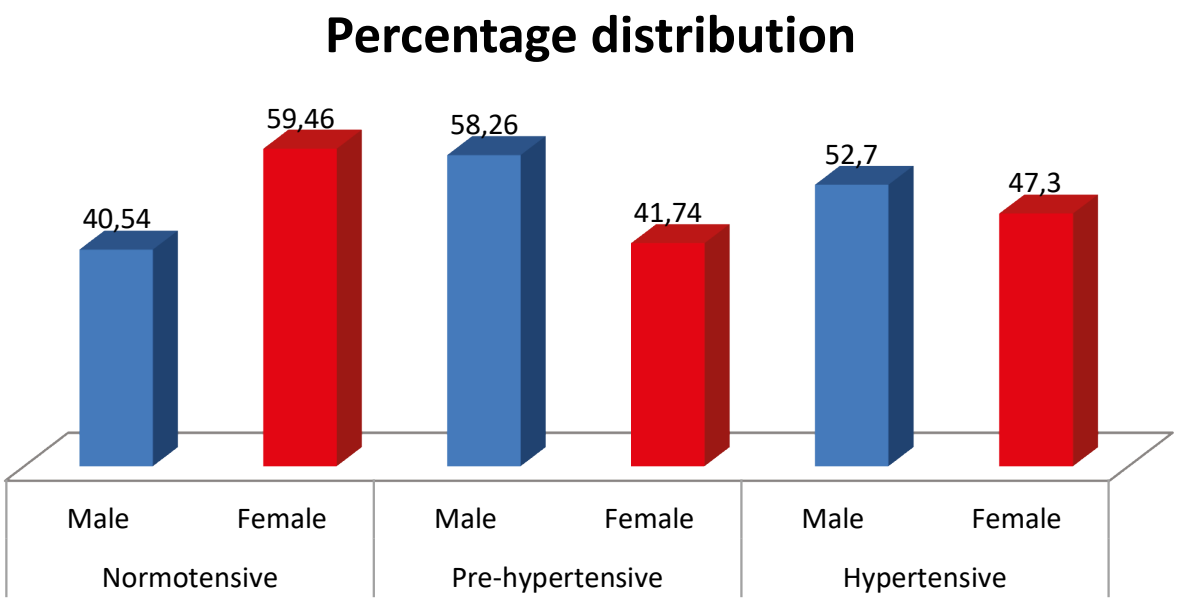

Fig. 1. Distribution of male and female subjects in different groups

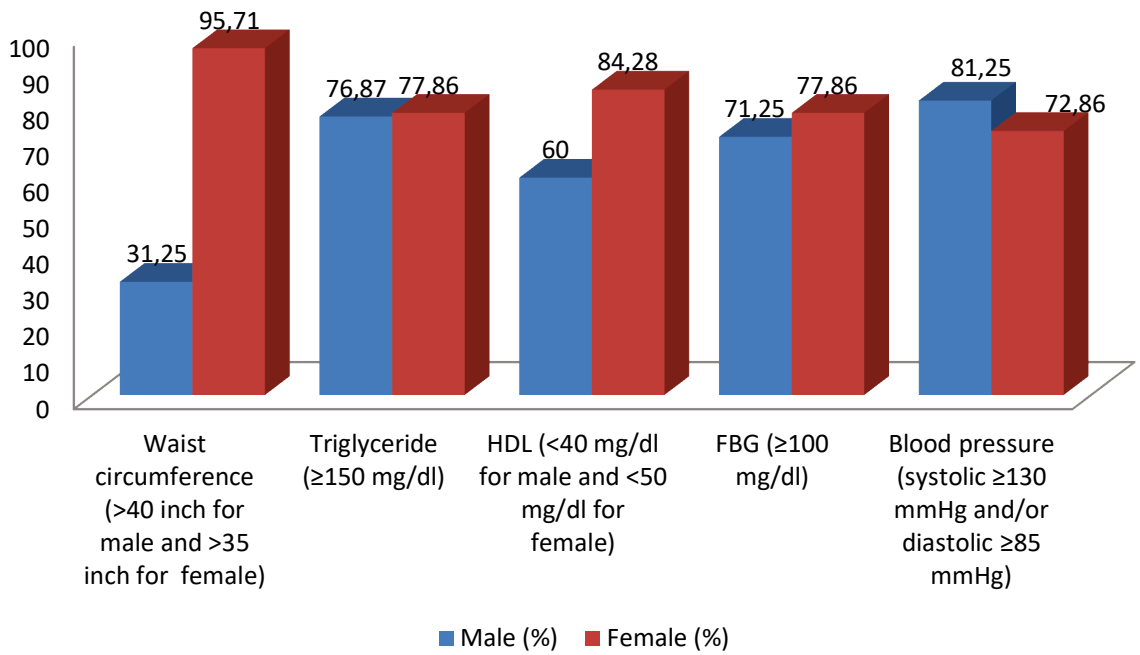

Fig. 2. Distribution of subjects on the basis of their inclusion criteria for metabolic syndrome

Table 1 depicts mean ± SD distribution of various parameters in normotensive male and female subjects. Significant difference was seen in mean values of height, waist- hip ratio of male and female normotensive metabolic subjects.

Table 1

Distribution of Anthropometric and Biochemical Parameters of Normotensive Group

Parameters	Male (N = 15)	Female(N = 22)	P value
	Mean ± SD	Mean ± SD	
Age	35.57 ± 10.23	39.09 ± 11.22	0.279
Weight	77.33 ± 12.27	70.23 ± 9.8	0.058
Height	1.66 ± 0.07	1.56 ± 0.06	0.000
BMI	28.2 ± 4.21	28.83 ± 4.06	0.648
Waist	39.34 ± 3.76	40.37 ± 2.97	0.360
Hip	38.76 ± 4.37	41.48 ± 4.36	0.071
WHR	1.01 ± 0.06	0.98 ± 0.05	0.031
SBP	115.07 ± 5	114.45 ± 6.70	0.710
DBP	78.80 ± 5.49	76.45 ± 5.89	0.230
FBG	129 ± 45.29	135.43 ± 54.97	0.071
Total Cholesterol	234.47 ± 71.06	199.05 ± 35.55	0.190
HDL	43.62 ± 15.36	38.30 ± 13.24	0.268
LDL	124.19 ± 34.84	122.47 ± 34.09	0.882
VLDL	35.22 ± 12.95	41.19 ± 15.19	0.221
TG	177.29 ± 30.57	179.01 ± 42.97	0.895

Note: BMI — Body Mass Index; WHR — Waist Hip Ratio; SBP- Systolic Blood Pressure; DBP — Diastolic Blood Pressure; HDL — High Density Lipoprotein; LDL–Low Density Lipoprotein; VLDL–Very Low-Density Lipoprotein; Significant, $p < 0.05$.

Table 2 depicts mean ± SD distribution of various parameters in pre-hypertensive male and female subjects. Significant difference was seen in mean values of age, weight, height, BMI, waist-hip circumference, and HDL of male and female pre-hypertensivemetabolic subjects.

Table 2

Distribution of Anthropometric and Biochemical Parameters Pre-hypertensive Group

Parameters	Male (N = 67)	Female(N = 48)	P value
	Mean ± SD	Mean ± SD	
Age	36.4 ± 10.58	45.75 ± 10.11	0.000
Weight	75.84 ± 10.08	70.13 ± 11.65	0.006
Height	1.67 ± 0.80	1.54 ± 0.08	0.000
BMI	27.2 ± 3.57	29.50 ± 4.67	0.003
Waist	38.96 ± 8.77	45.88 ± 17.94	0.007
Hip	39.14 ± 8.45	45.92 ± 9.05	0.015
WHR	1 ± 0.06	1.008 ± 0.053	0.296
SBP	132.6 ± 4.95	132.17 ± 4.75	0.641
DBP	86.18 ± 4.99	86.96 ± 5.17	0.418
FBG	114.78 ± 35.85	123.04 ± 31.2	0.201
Total Cholesterol	193.15 ± 39.59	205.32 ± 41.12	0.193

End of the table 2

Parameters	Male (N = 67)	Female(N = 48)	P value
	Mean ± SD	Mean ± SD	
HDL	39.73 ± 10.7	44.34 ± 12.37	0.035
LDL	113.3 ± 34.62	117.26 ± 33.77	0.542
VLDL	36.11 ± 16.3	35.88 ± 14.84	0.940
TG	168.52 ± 52.33	160.5 ± 40.32	0.376

Table 3 depicts mean ± SD distribution of various parameters in hypertensive male and female subjects. There was significant difference of mean values of weight, height, BMI, and waist- hip circumference of male and female hypertensive metabolic subjects. However, both male and female participants in this study had higher anthropometric and biochemical markers.

Table 3

Distribution of Anthropometric and Biochemical Parameters of Hypertensive Group

Parameters	Male (N = 78)	Female(N = 70)	P value
	Mean ± SD	Mean ± SD	
Age	45.36 ± 10.87	47.37 ± 11	0.265
Weight	77 ± 12.27	70.7 ± 12.86	0.003
Height	1.68 ± 0.07	1.56 ± 0.07	0.000
BMI	27.24 ± 3.96	29.1 ± 5.62	0.021
Waist	40.72 ± 11.08	45.93 ± 16.49	0.024
Hip	41.03 ± 10.51	46.27 ± 17.24	0.025
WHR	0.99 ± 0.06	1 ± 0.053	0.593
SBP	155.72 ± 18.39	154.66 ± 17.34	0.719
DBP	96.9 ± 13.12	94.6 ± 6.8	0.191
FBG	145.73 ± 55.79	143.14 ± 52.64	0.773
Total Cholesterol	207.85 ± 37.27	206.9 ± 39.07	0.899
HDL	39.34 ± 11.95	39.34 ± 11.62	0.999
LDL	122.87 ± 29.91	121.53 ± 32.28	0.793
VLDL	40.02 ± 18.74	38.95 ± 14.35	0.699
TG	181.33 ± 62.52	168.38 ± 43.57	0.150

In this observational study, we evaluated patients for metabolic syndrome who attended Government RDBP Jaipuria Hospital in Jaipur's Medicine department's outdoor patient's department (OPD). These people were divided into three groups: normotensive (37) [male (40.54 %); female (59.45 %)], pre-hypertensive (115) [male (58.26 %); female (41.74 %)], hypertensive (148) [male (52.7 %); female (47.3 %)] (figure 1). Based on the criteria established by the American Heart Association (AHA) for Asians [16].The emergence of cardiovascular disease is linked to metabolic syndrome. There is a two-fold increase in the risk of cardiovascular disease and a four-fold increase in the risk of fatal coronary heart disease. In India and other South Asian nations, the prevalence of obesity and

metabolic syndrome is rising rapidly, increasing mortality and morbidity from CVD and T2DM [17, 18].In the current study, there were no such significant differences between male and female participants across all groups in several parameters. According to the findings of our study, metabolic hypertensive patients were aged than pre-hypertensive and normotensive patients. The mortality rate attributable to the metabolic syndrome and its risk factors differ by gender and age. Our findings show that the prevalence of MetS rises with age and is more common in men than in women. Multiple studies have also shown that «modernization» causes the change in physical activity levels, adiposity, dietary, and psychosocial stress, which raise blood pressure and exacerbate age-related elevations in blood pressure. The waist-hip ratio and body mass index were nearly same across all BP groups. According to the acceptable body mass index provided by the WHO for Asian populations, body mass index indicates that all participants were obese [19].And WHR was also more than cut-off points for Asians used (0.95 in men and 0.80 in women) [20].In our study, the hypertension and prehypertensive groups had higher fasting blood glucose levels than the normotensive group. FBG was shown to be positively associated with BP, according to Lu Y et al. In males and females, BP and FBG had different associations [21].The renin — angiotensin aldosterone system (RAAS), which affects blood pressure, may be altered if the FBG level rises as a result of metabolic diseases, obesity, and hyperglycemia with insulin resistance [22].In the current study, all groups had raised levels of total cholesterol, LDL, VLDL, and TG, although hypertensive and pre-hypertensive had greater levels than normotensive. This exceeded the criteria for cholesterol targets for South Asians provided by the ATP III study from the National Cholesterol Education Program in the United States [23].However, in the current investigation, metabolic individuals with hypertension and pre-hypertension had low HDL levels. The findings of the Choudhury KN et al. research support our findings that hypertension individuals had considerably higher mean serum TC, TG, and LDL levels than normotensive patients [24].Additionally, the mean HDL level was statistically significantly lower in hypertensives compared to normotensives. Because insulin influences TG and HDL–C metabolism, the occurrence of hypertriglyceridemia and low HDL concentrations generally never occurred as independent illnesses and were almost usually associated to insulin resistance [25]. In this present study hypertension and pre-hypertension were more prevalent in the population with metabolic syndrome.

Limitations

Large-scale prospective studies might demonstrate a significant association between the prevalence of hypertension and the risk of metabolic syndrome in both genders.

Conclusion

The above study's findings suggest that hypertension and pre-hypertension were more prevalent in the population with metabolic syndrome. Additionally, hypertensives have a higher chance than pre-hypertensive and normotensive individuals of manifesting dyslipidemia, which includes raised TC, LDL, and TG values as well as decreased HDL cholesterol. But as they become older, these normotensive and pre-hypertensive individuals become more likely to develop hypertension. Findings of this study indicate that more than one metabolic risk factor is responsible metabolic syndrome, it is cumulative. Findings of this study sought that knowledge of factors involved will be helpful for making treatment plan.

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Состояние артериального давления у пациентов с метаболическим синдромом

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Аннотация. *Актуальность.* Метаболический синдром (МетС) — это наличие множества отклонений, таких как абдоминальное ожирение, гипертония, дислипидемия и непереносимость глюкозы. Возникновение МетС у людей с гипертонической болезнью связано с плохо управляемой гипертонией. Одним из параметров диагностики синдрома является наличие повышенного артериального давления; тем не менее, исследования показывают, что пациенты с МетС часто страдают гипертонией. *Материалы и методы.* 300 субъектов, страдающих обменом веществ, были выбраны из медицинского OPD в качестве участников исследования на основе определения МетС, содержащегося в совместном промежуточном заявлении 2009 г. Они были разделены на три группы (нормотензивные, предгипертензивные и гипертонические) на основании показаний

артериального давления, соответствующих азиатским критериям артериального давления Американской кардиологической ассоциации (AHA). Для сбора данных записывались следующие параметры: антропометрические (вес, рост, индекс массы тела, соотношение талии и бедер), кровяное давление, биохимические (глюкоза в крови натощак, параметры липидного профиля). *Результаты и обсуждение.* Согласно показаниям артериального давления в покое, из 300 участников МетС 37 имели нормотензивное давление [мужчины (40,54 %); женщины (59,45 %)], 115 были в предгипертензивном состоянии [мужчины (58,26 %); женщины (41,74 %), 148 человек страдали гипертонической болезнью [мужчины (52,7 %); женщины (47,3 %)]. По нескольким параметрам не было столь существенной разницы между участниками мужского и женского пола во всех группах. Однако уровни общего холестерина, триглицеридов и липопротеинов низкой плотности в крови были значительно выше у гипертонических и предгипертонических участников метаболического процесса, чем у нормотензивных субъектов, тогда как уровни липопротеинов высокой плотности были ниже. *Выводы.* Результаты исследования показывают, что гипертония и предгипертензия более распространены в группе с метаболическим синдромом. Кроме того, у гипертоников выше вероятность проявления дислипидемии.

Ключевые слова: артериальное давление, артериальная гипертензия, метаболический синдром, гипертония, факторы риска

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