DOI: 10.7860/NJLM/2024/66548.2828

Original Article

Biochemistry Section

Prevalence of Metabolic Syndrome amongst Undergraduate Medical Students: A Cross-sectional Study

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ABSTRACT

Introduction: Metabolic Syndrome (MS) is a cluster of interconnected metabolic abnormalities involving glucose metabolism, lipid metabolism, elevated Blood Pressure (BP), and central obesity. It increases the risk of type-2 diabetes, cardiovascular disease, and mortality. Medical students during the Coronavirus Disease-2019 (COVID-19) pandemic were forced to remain indoors with minimal physical activity, improper sleep patterns, and long sessions of online classes. All these factors may cause various metabolic disturbances, posing them at risk for developing MS.

Aim: To study the prevalence of MS among Undergraduate (UG) medical students and assess the predictive risk factors for MS among them.

Materials and Methods: The present cross-sectional study was conducted in the Department of Biochemistry, ESIC Medical College and Hospital, Hyderabad, Telangana, India, from June 2022 to August 2022. A total of 170 UG medical students, aged between 18-24 years of both genders, were included in the study. The International Diabetes Federation (IDF) criteria were used for diagnosing MS. Data for anthropometric measurements (height, weight, Waist Circumference (WC), Body Mass Index (BMI), and BP were collected. Blood samples were collected to analyse Fasting Blood Sugar (FBS), Triglyceride (TG), and High-Density Lipoproteins (HDL). Unpaired t-test was used to compare two groups. Pearson's correlation coefficient was used to assess the association between different components of MS and anthropometric parameters.

Results: Amongst the total sample of 170 undergraduate medical students, the prevalence of MS was 7.6% (n=13) of the sample population, almost equivocal among males 7 (9.7%) and females 6 (6.1%). Increased WC was seen in 75 (44.1%), raised Systolic BP was found in 24 (14.1%), raised Diastolic BP was found in 15 (20.8%), raised TG was found in 10 (5.9%), decreased HDL was found in 43 (25.3%), and increased FBS was found in 17 (10%) students. Regression analysis showed that high BMI, WC, and impaired FBS were the most critical predictive risk factors of MS.

Conclusion: In the present study, the prevalence of MS in medical UG students was found to be 7.6%, and factors such as BMI, WC, and impaired FBS can be used to predict the risk of MS in them.

Keywords: Lifestyle modification, Lipid metabolism, Obesity, Waist circumference

INTRODUCTION

The MS, also known as Cardio-MS/Syndrome X/insulin resistance syndrome, is an emerging public health pandemic, accounting for a major proportion of deaths among non-communicable diseases [1,2]. It is estimated that 20-25% of adults worldwide suffer from MS, and over the years, an increasing trend will be observed [3,4]. The prevalence of MS in India is around 30%, and the burden increases steadily across the age groups from 13% (18-29 years group) to 50% (50-59 years), with an increased preponderance towards females (females 35% >males 26%) [5].

MS is a cluster of metabolic abnormalities that are related to each other and characterised by glucose and lipid dysregulation, insulin resistance, abdominal obesity, and elevated BP [6]. It is a pre-morbid condition associated with a risk of developing Type 2 Diabetes Mellitus (T2DM), polycystic ovary syndrome, fatty liver, asthma, sleep disorders, cancer, and cardiovascular disease [7], and it might even lead to complicated events such as strokes, heart attacks, and sudden cardiac death [8]. Factors such as poor diet, physical inactivity, obesity, and genetics play a contributing role [9] in the development of MS.

Various criteria such as National Cholesterol Education Program (NCEP) III and International Diabetes Federation (IDF) criteria are used for the diagnosis of MS [6,10]. Early detection of MS or its components among medical students can alert them to practice appropriate lifestyle modifications such as dietary changes and regular physical exercises, helping to decrease morbidity and mortality [11,12]. Undergraduate (UG) medical students lead a sedentary lifestyle with minimal physical activity, altered sleep patterns, and live in a stressful environment with unhealthy food habits. These alterations became more pronounced during the COVID-19 pandemic when they were forced to remain indoors with long sessions of online classes. All these factors might cause metabolic disturbances, posing a risk of developing MS [13].

The present study will be beneficial in understanding the importance of medical UG health, as they will be future health professionals, and thus, direct impact of their ill health on societal and family health. Many similar studies have been conducted all over India [11-14], but most of them were done before the COVID-19 pandemic, and prolonged sitting for online lectures and physical inactivity during COVID-19 may affect metabolism.

Hence, this study was undertaken with the aim to estimate the prevalence of MS and its components such as WC, FBS, TG levels, HDL level, and BP among UG medical students studying in a Government Institute in Telangana and to assess the predictive risk factors for MS among them.

MATERIALS AND METHODS

The present cross-sectional study was conducted in the Department of Biochemistry, ESIC Medical College and Hospital, Hyderabad, Telangana, India, from June 2022 to August 2022. Institutional Ethics Committee approval (ESICMC/SNR/IEC-S0125/02-2022)

was obtained prior to the start of the study. Informed consent was obtained from the study participants.

Inclusion criteria: After obtaining informed consent, a total of 170 UG MBBS students, irrespective of the year in college, aged between 18-24 years of both genders, were included in the study.

Exclusion criteria: Students with pre-existing co-morbidities like Type I DM and autoimmune diseases were excluded.

Sample size: The sample size was calculated using the formula:

$$(Z1-\alpha/2)^2 (p) (q)/d^2;$$

p=29% [4],

q=71%

$(Z1-\alpha/2)^2$-95% confidence interval,

d-margin of error=5%

So, calculated sample size was=170

Procedure

Data collection: A pretested semi-structured proforma was used to collect the demographic details, dietary habits, and family history of medical disorders of the participants. The International Physical Activity Questionnaire (IPAQ)-Short form was used to assess physical activity and inactivity [15]. Anthropometric measurements (height, weight, WC) and BP were recorded. WC (in cm) was measured according to the WHO STEPS PROTOCOL [10] using a stretch-resistant tape. BMI was calculated as Weight (kg)/Height (m^2).

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Later, 5 mL of venous blood was collected from all study participants in the fasting state into a grey top vacutainer (2 mL) and red top vacutainers (3 mL). The samples were centrifuged at 3000 rpm for 15 minutes, and the fluoride plasma was analysed for fasting glucose (Hexokinase method) levels, and serum was analysed for HDL cholesterol (homogeneous enzymatic colorimetric assay) and TG (GPO-POD method) levels.

The IDF (2005) criteria [6] were used for the diagnosis of MS, which recommended that to diagnose MS, one must have central obesity (WC males ≥90 cm, females ≥80 cm for Asians) along with any two of the following four components:

1. Raised Triglycerides (TG): ≥150 mg/dL or specific treatment for this lipid abnormality.
2. Reduced HDL cholesterol: <40 mg/dL (males), <50 mg/dL (females), or specific treatment for this lipid abnormality.
3. Raised Blood Pressure (BP): Systolic ≥130 mmHg or diastolic ≥85 mmHg or treatment of previously diagnosed hypertension.
4. Raised fasting plasma glucose: ≥100 mg/dL or previously diagnosed type 2 diabetes.

If BMI >30 kg/m^2, central obesity was assumed, and WC was not measured.

STATISTICAL ANALYSIS

The obtained data were tabulated in a Microsoft Excel sheet and analysed using MedCalc software (version 22.0). Parametric data were expressed as mean and standard deviation. Results were presented as text, tables, and diagrams. The unpaired t-test was used to compare means ($p<0.05$ was considered significant). Regression analysis was performed to establish the most predictive risk factors for MS in UG medical students.

RESULTS

Out of 170 participants, 98 (57.6%) were females and 72 (42.4%) were males, with a mean age of 20.6±1.4 years.

A family history of diabetes was more prevalent, followed by hypertension, among the participants. The majority of the respondents followed a mixed diet, consumed only one fruit per day, had at least one sugary beverage every day, and had junk and fast food at least 2-3 times a week. Alcohol was consumed by 14.6% of the participants, and 9% had history of smoking. Although some students had rigorous to moderate physical activity, the majority of them sat for more than eight hours per day [Table/Fig-1].

Gender	Male	72 (42.4%)
	Female	98 (57.6%)
Family history	Type II diabetes mellitus	66 (38.9%)
	Hypertension	56 (32.8%)
	Dyslipidaemias	9 (5.3 %)
	Cardiovascular diseases	27 (16 %)
	No significant family history	12 (7 %)
Diet	Vegetarian	31 (18.4 %)
	Mixed diet	136 (79.7 %)
	Vegan	1 (0.6 %)
	Gluten free diet	2 (1.2%)
Hours of sleep (hours/ day)	<6	25 (14.7 %)
	6-8	135 (79.4 %)
	>8	10 (5.9%)
Physical activity (hours/ day)	Vigorous physical activity	44 (25.9 %)
	Moderate physical activity	70 (41.2 %)
	Minimal physical activity	56 (32.9%)
Sittting in week days (hours/day)	>8	108 (63.5%)
	<8	62 (36.5%)
Fruit consumption	0 fruit per day	38 (22.4%)
	1 fruit per day	89 (52.3%)
	2 fruit per day	32 (18.8%)
	3 fruit per day	11 (6.5%)
Junk/fast food consumption	0-1/week	67 (39.2%)
	2-3/week	73 (43%)
	4-5/week	18 (10.8%)
	>5/week	12 (7%)
Alcohol consumption	Yes	25 (14.6%)
	No	145 (85.4 %)
Smoking	Yes	15 (9%)
	No	155 (91%)

[Table/Fig-1]: Demographic data of the study participants.

Males had significantly higher weight, height, Waist Circumference (WC), and Triglyceride (TG) levels compared to females. This shows that the components of Metabolic Syndrome (MS) were more deranged in males compared to females [Table/Fig-2].

Parameter	Gender	N	Mean	Std. Deviation	p-value
Age (years)	Male	72	20.17	1.574	0.42
	Female	98	19.99	1.272	
Weight (in Kg)	Male	72	68.936	11.0104	**<0.0001**
	Female	98	57.383	9.0285	
Height (in m)	Male	72	1.7369	0.07569	**<0.0001**
	Female	98	1.5867	0.06095	
BMI (kg/m^2)	Male	72	22.8686	3.32034	0.98
	Female	98	22.8668	3.47530	

Waist Circumference (WC) (cm)	Male	72	86.931	9.4516	**0.0006**
	Female	98	81.791	9.5674	
SBP (mm of Hg)	Male	72	121.96	9.654	**<0.0001**
	Female	98	114.18	8.787	
DBP (mm of Hg)	Male	72	73.83	9.457	**0.04**
	Female	98	71.16	7.439	
FBS (mg/dL)	Male	72	91.115	8.0431	0.46
	Female	98	90.100	9.2470	
HDL cholesterol (mg/dL)	Male	72	50.069	9.8845	**0.012**
	Female	98	53.593	8.0843	
Triglycerides (TG) (mg/dL)	Male	72	100.075	45.1496	**0.0007**
	Female	98	81.318	25.4686	

[Table/Fig-2]: Anthropometric, clinical and biochemical parameters of the participants. BMI: Body mass index; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; FBS: Fasting blood sugar; HDL: High density lipoprotein

The prevalence of components of MS revealed that increased WC and impaired High-density Lipoprotein (HDL) were high among females compared to males. Elevated Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) were seen more in males compared to females. The prevalence of increased Fasting Blood Sugar (FBS) was almost equal in both males and females, whereas the prevalence of increased TG levels was high in males compared to females [Table/Fig-3].

S. No.	Components	% (n)		
		Males	Females	Total
1	Increased Waist Circumference (WC)	24 (33.3%)	51 (52%)	75 (44.1%)
2	Raised Triglycerides (TG)	8 (11.1%)	2 (2.0%)	10 (5.9%)
3	Decreased HDL cholesterol	12 (16.6%)	31 (31.6%)	43 (25.3%)
4	Raised SBP	22 (30.6%)	2 (2.0%)	24 (14.1%)
5	Raised DBP	12 (16.6%)	3 (3.1%)	15 (20.8%)
6	Raised FBS	8 (11.11%)	9 (9.2%)	17 (10%)

[Table/Fig-3]: Prevalence of components of Metabolic Syndrome (MS) in the participants.

Among the 170 participants, 13 (7.6%) students were found to be positive for Metabolic Syndrome (MS) based on IDF criteria [10]. The prevalence was almost equal among males, with 7 (9.7%) affected, and females, with 6 (6.1%) affected.

In the present study, a total of 13 participants had MS. Out of these 13 subjects with MS, four had a normal BMI, five were overweight, and four were obese. The average BMI of those with MS was 27.54 kg/m^2, which falls in the overweight category, whereas in those without MS, it was in the normal range, i.e., 18.4-24.9 kg/m^2. HDL and TG levels were more deranged in males compared to females. All males with MS had a higher Waist Circumference (WC). Higher Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Fasting Blood Sugar (FBS) were also observed in males compared to females [Table/Fig-4].

Variable	Males with MS (%)	Females with MS (%)
BMI (Kg/m^2)		
Normal	2 (28.6)	2 (33.3)
Underweight	-	-
Overweight	3 (42.8)	2 (33.3)
Obese	2 (28.6)	2 (33.3)
HDL (mg/dL)		
<40	4 (57.2)	2 (33.3)
>40	3 (42.8)	4 (66.7)
TG (mg/dL)		
<150	3 (42.8)	5 (83.3)
>150	4 (57.2)	1 (16.7)
Waist Circumference (WC) (cm)		
<90	-	2 (33.3)
>90	7 (100)	4 (66.7)
SBP (mm of Hg)		
<130 mmHg	3 (42.8)	5 (83.3)
>130 mmHg	4 (57.2)	1 (16.7)
DBP (mm of Hg)		
<85 mmHg	1 (14.3)	5 (83.3)
>85 mmHg	6 (85.7)	1 (16.7)
FBS (mg/dL)		
<100	3 (42.8)	-
>100	4 (57.2)	6 (100)

[Table/Fig-4]: Distribution of components of Metabolic Syndrome (MS) among males and females (total n=13).

[Table/Fig-5] shows the association of different variables in the order of their entry into the regression equation in each group. The regression model showed that students with higher BMI, WC, and FBS were at a greater risk of developing MS.

Variable	Odd's ratio	95% CI	p-value
Age (years)	0.9330	0.5162 to 1.6863	0.82
BMI (kg/m^2)	1.4548*	0.9006 to 2.3498	**0.013**
Waist Circumference (WC) (cm)	1.2669*	1.0513 to 1.5268	**0.013**
SBP (mm of Hg)	0.9655	0.8510 to 1.0954	0.58
DBP (mm of Hg)	0.9 711	0.8264 to 1.1412	0.72
FBS (mg/dL)	1.1534*	1.0245 to 1.2984	**0.02**
HDL cholesterol (mg/dL)	0.8597	0.7102 to 1.0407	0.12
Triglycerides (TG) (mg/dL)	1.0104	0.9864 to 1.0350	0.4

[Table/Fig-5]: Risk factors for MS screening.
*p-values <0.05

DISCUSSION

Recently, there has been an upsurge in the prevalence of Metabolic Syndrome (MS) in developing countries like India due to rapid economic development, leading to drastic changes in lifestyle patterns and nutrition [16]. Patients with MS have a four-fold increased risk of developing stroke and myocardial infarction, as well as a two-fold risk of dying from similar events compared to those without MS, regardless of their previous cardiovascular history [17,18]. Identifying individuals with or at risk of developing MS is crucial in informing them about the probabilities of adverse outcomes and emphasises the urgent need for prevention and treatment [3].

The present study focused on medical students aged between 18 and 25 years. The prevalence of MS in the present study population was found to be 7.6%, with a higher prevalence among males (9.7%) compared to females (6.1%). Most of the subjects had at least one abnormal biochemical or anthropometric parameter contributing to MS. Several studies have been conducted throughout India using IDF and NCEP guidelines, resulting in varying prevalence percentages [11-14]. A summary of their findings is presented in [Table/Fig-6].

Study	Location/ year	Criteria used	Sample size	Prevalence of MS (%)	Male (%)	Female (%)
Present study	Hyderabad, Telangana	IDF	170	7.6	9.7	6.1
Teli A et al., [11]	Belagavi, Karnataka 2019	IDF	120	10.83	9.43	11.94

Kandula SGNSV et al., [12]	Andhra Pradesh 2017	IDF	400	6	12.19	1.7
Kumar S et al., [13]	Patna 2021	IDF	150	20	23.3	17.8
Issac R et al., [14]	Thrissur, Kerala 2020	NCEP	146	2.1	-	-

[Table/Fig-6]: Studies done on Metabolic Syndrome (MS) in UG Medical Students in India.

In the present study, the authors adopted the IDF criteria for diagnosing MS, and the prevalence was almost equal among males and females, similar to the study conducted by Teli A et al., However, studies by Kandula SGNSV et al., and Kumar S et al., showed a higher prevalence among males compared to females, possibly due to increased consumption of junk food, sedentary lifestyle, and lack of exercise [11-13]. The study by Issac R et al., demonstrated a very low prevalence of MS, likely due to differences in the study setting and population [14]. Differences in prevalence rates among these studies may be attributed to the diverse cutoff points and sets of parameters used by the respective criteria.

The most prevalent component of Metabolic Syndrome (MS) in the present study was increased Waist Circumference (WC) at 44.1%, followed by decreased High-Density Lipoprotein Cholesterol (HDL-C) at 25.3%, which is in line with the studies conducted by Teli A et al., and Kumar S et al., However, the study by Issac R et al., found decreased HDL-C to be the most common component [11,13,14]. In females, increased WC was the most prevalent component of MS, followed by decreased HDL-C. In males, increased WC was the most prevalent, followed by increased Systolic Blood Pressure (SBP). Elevated SBP and Diastolic Blood Pressure (DBP) were more prevalent among males compared to females, similar to the study by Issac R et al., [14].

Higher fasting blood glucose, Body Mass Index (BMI), and WC significantly increased the prevalence of MS, while age, blood pressure, and dyslipidemias showed no significant independent association with MS in the present study population. Similarly, Issac R et al., demonstrated that WC measurement and BMI can be useful in predicting MS [14]. Screening and early targeted intervention are necessary for preventing MS in the study population.

The study participants consumed junk food and fast food regularly, with low consumption of vegetables and fruits per day. Similar findings were reported by Kandula SGNSV et al., who demonstrated a significant relationship between MS and lifestyle habits such as smoking, alcohol consumption, junk food consumption, and sleep duration [12]. As dietary habits and lifestyle patterns developed during this stage often persist into adulthood, further assessment is needed to understand the impact of changes on the components of MS.

The majority of the study population had a habit of sitting for long continuous hours during lectures and in the library, contributing to a sedentary lifestyle with limited physical activity [15]. A significant family history of diabetes mellitus, hypertension, cardiovascular disease, and dyslipidemias was observed in many study subjects (93%). This has also been demonstrated in other studies conducted in the Indian population [11,12]. These findings highlight the importance of addressing risk factors for MS in early adulthood [16]. Health screening for MS, adherence to proper dietary and lifestyle modifications such as regular physical exercise and yoga, both as therapeutic and preventive measures, would help decrease the prevalence of MS among medical students [17,18].

Limitation(s)

This study was conducted at a single centre, therefore the results cannot be generalised to the entire population. Further evaluation is needed to assess the effects of lifestyle changes on the risk of Metabolic Syndrome (MS).

CONCLUSION(S)

In the present study, the authors conclude that there was a significant prevalence (7.6%) of Metabolic Syndrome (MS) among undergraduate medical students. Females had increased Waist Circumference (WC) and Body Mass Index (BMI) compared to males. BMI, WC, and impaired Fasting Blood Sugar (FBS) can predict the risk of MS in this population. Lifestyle modification and targeted intervention can help reduce the risk of MS in undergraduate medical students. Further longitudinal studies that evaluate the effects of these habits on BMI-related outcomes with long-term follow-up will help validate the current findings.

Acknowledgement

The authors would like to express their gratitude to all the participants who dedicated their valuable time and effort to participate in the study. They would also like to acknowledge the staff of the Department of Biochemistry, ESICMCH, for their immense support in the laboratory work.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jul 18, 2023
- Manual Googling: Nov 21, 2023
- iThenticate Software: Nov 25, 2023 (6%)

ETYMOLOGY: Author Origin

EMENDATIONS: 8

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Jul 17, 2023**
Date of Peer Review: **Sep 02, 2023**
Date of Acceptance: **Nov 26, 2023**
Date of Publishing: **Apr 01, 2024**