

Original Article

Stress prevalence and associated risk factors among patients with metabolic syndrome defined by NCEP ATP III criteria

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Abstract

Metabolic syndrome (MetS) is a major cardiometabolic disorder characterized by the clustering of abdominal obesity, hypertension, impaired glucose regulation, hypertriglyceridemia, and reduced high-density lipoprotein cholesterol. Psychosocial stress may further increase the disease burden by adversely affecting lifestyle behaviors, treatment adherence, and control of cardiometabolic risk factors. However, evidence regarding the prevalence and determinants of stress among individuals with MetS in routine clinical settings remains limited. To determine the prevalence of stress and identify its associated factors among adults with metabolic syndrome. A hospital-based analytical cross-sectional study was conducted among 486 adult participants. MetS was defined according to the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria. Stress was assessed using the stress subscale of the Depression, Anxiety and Stress Scale-21 (DASS-21). Socio-demographic, behavioral, clinical, and metabolic characteristics were collected using a structured proforma. Associations between stress and potential predictors were assessed using bivariate analysis, followed by multivariable logistic regression to identify independent correlates. Metabolic syndrome was present in 59.5% of participants. Overall, 61.3% experienced stress. Stress was significantly more prevalent among participants with MetS than among those without MetS (72.7% vs. 44.7%). Among individuals with MetS, stress prevalence increased progressively with a greater number of abnormal NCEP ATP III components. Poor sleep quality showed the strongest independent association with stress (AOR=3.81), while lower educational status, low physical activity, female sex, abdominal obesity, and greater metabolic clustering were also independently associated with stress. Stress was highly prevalent among individuals with MetS and was strongly associated with adverse behavioral, socioeconomic, and metabolic characteristics. Routine screening and management of psychosocial stress should be integrated into comprehensive MetS care.

Keywords: metabolic syndrome, stress, NCEP ATP III, DASS-21, sleep quality, physical activity

Abbreviations: AOR – Adjusted Odds Ratio; BMI – Body Mass Index; BP – Blood Pressure; CI – Confidence Interval; DASS-21 – Depression Anxiety Stress Scale-21; DBP – Diastolic Blood Pressure; FBG – Fasting Blood Glucose; HDL – High-Density Lipoprotein; MetS – Metabolic Syndrome; NCEP ATP III – National Cholesterol Education Program Adult Treatment Panel III; OR – Odds Ratio; SBP – Systolic Blood Pressure; SES – Socioeconomic Status; TG – Triglycerides; WC – Waist Circumference.



Introduction

Metabolic syndrome is a modern day public health dilemma as it defines the co-occurrence of abdominal obesity, impaired fasting glycemia or diabetes mellitus (DM), hypertension and dyslipidaemia that dramatically increases risk for type 2 DM, atherosclerotic cardiovascular disease (ASCVD) chronic kidney diseases and all-cause mortality [1]. Metabolic syndrome is defined as the presence of at least three out of five cardiometabolic risk factors; this harmonised definition proposed by major international organisations has become a standard for clinical and epidemiologic research [2]. The global socio-economic burden of metabolic syndrome is high and also rapidly rising. A pooled global prevalence figure based on around 28 million people found a variation from 12.5% to 31.4%, dependent upon the diagnostic definition, while an later worldwide trend analysis estimated approximately 1.54 billion adults had metabolic syndrome by 2023, Can counteract risk of cardio-metabolic around the world effective treatment Because all reduce heart problems for health In India pooled prevalence was 30% (95% CI, 28%–33%) with Logistic testing indicate a high national burden of cardiometabolic [3]. Systematic review & Meta-analysis among adults Because metabolic syndrome is associated with sedentary lifestyle, poor diet, obesity, insulin resistance and low-grade chronic inflammation, it has increasingly been viewed as not simply a disorder of metabolism but also an integrated condition driven by biological and behavioural processes in conjunction with psychosocial factors [4, 5].

These psychosocial factors include stress, which is increasingly recognized for its potential contribution to metabolic dysregulation via behavioural and physiological pathways. Chronic perceived stress has been associated with harmful lifestyle practices, including poor nutrition, lack of exercise, disrupted sleep, emotional eating, and decreased self-efficacy, which can aggravate obesity and metabolic complications [6]. Physiologically, chronic stress can trigger the hypothalamus-pituitary-adrenal pathway and sympathetic nervous system, elevate cortisol levels, induce visceral fat deposition, disrupt blood glucose balance, and enhance inflammatory signalling pathways implicated in metabolic syndrome [7].

There is also epidemiological evidence of a connection between stress and metabolic syndrome, albeit one that differs in strength depending on the study populations and stress sources involved. In a systematic review and meta-analysis of psychological stress

and metabolic syndrome, researchers found that the connection was contingent upon the stressor, implying that the link was not straightforward [8]. Recent observational research demonstrates that perceived stress and diverse types of psychosocial stressors are associated with cardiometabolic risk indicators and selected metabolic syndrome elements, including high blood pressure and abdominal obesity, even though there is inconsistent evidence of their links to the syndrome as a whole [9].

Nonetheless, there still exists an unfulfilled area in the current literature regarding this topic. A significant amount of existing studies have been conducted to evaluate the association between stress and the likelihood/occurrence of metabolic syndrome among general, occupation-specific, or mixed adult populations; however, little is known about the prevalence of stress among those patients who have already been diagnosed with metabolic syndrome [8]. Moreover, previous studies have differed in terms of defining what stress is, case finding approaches, and covariates adjustment, leaving the question unanswered as to whether some or other factors actually associate with the presence of stress in patients with metabolic syndrome [10]. The significance of studying this issue is justified by the fact that, since patients suffering from this disease are supposed to lead an active lifestyle and take medicines regularly, it is possible that unrecognized stress may hinder their therapy. That is why, our study aimed at evaluating the prevalence of stress among patients diagnosed with metabolic syndrome and identifying associated factors.

Material and methods

Study design

This study was performed as an analytical cross-sectional study conducted within a hospital setting aimed at establishing the prevalence of stress among adult individuals suffering from metabolic syndrome and identifying the factors contributing to stress levels in this particular group. The cross-sectional research design was appropriate for use in the study because the study objectives sought to classify individuals into two groups (MetS present or MetS absent), evaluate the magnitude of the prevalence of stress among study subjects, and investigate the relationship between the dependent variable (stress) and independent variables.

Study setting and study population

The current study was conducted within the outpatient clinics providing General Medicine/Metabolic/NCD services at a selected tertiary care hospital. Adults attending the outpatient clinics during the period of the research were recruited to participate in the study if they fulfilled the inclusion criteria. The target population was that of adults attending the clinic with problems such as obesity, hypertension, diabetes, dyslipidemia, or other conditions related to metabolic syndrome. This particular location was considered appropriate since a diagnosis of MetS involves measurements including anthropometric measures, blood pressure, and biochemical markers.

Sample size

The minimum required sample size for the study was calculated using the single population proportion formula for prevalence studies, $n = Z^2 pq / d^2$, using a 95% confidence level ($Z=1.96$), 5% absolute accuracy, and assuming a prevalence (p) of 50% since there was no accurate estimate from the local population, thus giving the largest conservative sample size. With this information, the minimum sample size required was 384. By adding 10%, to cater for non-response and incompleteness, the sample increased to 423 respondents. The total number of people who participated during the research period and had all their details was 486. This sample exceeded the minimum number required and helped give more accurate estimates of the prevalence rate.

Sampling technique

A consecutive sampling technique was used. All eligible adult patients attending the selected clinic during the data collection period were approached sequentially and assessed until the required sample was exceeded. This method was operationally appropriate for a hospital-based cross-sectional study and ensured systematic recruitment of participants without arbitrary selection.

Definition of metabolic syndrome case

Metabolic syndrome was diagnosed based on NCEP ATP III criteria. Subjects were categorized as MetS present when at least three out of the following five factors were observed: waist circumference >102 cm in men and >88 cm in women, triglycerides ≥ 150 mg/dL, HDL cholesterol level <40 mg/dL in men or <50 mg/dL in wom-

en, systolic/diastolic blood pressure $\geq 130/85$ mmHg or taking anti-hypertensive drugs, fasting plasma glucose ≥ 110 mg/dL or being treated for elevated glucose. Subjects who showed less than three abnormal parameters were categorized as MetS absent. Such a case definition led to the creation of MetS present and MetS absent groups used in Results section [11].

Measurement of stress

Stress levels were measured using the Depression Anxiety Stress Scale-21 (DASS-21) stress subscale. The DASS-21 contains 21 items divided equally across depression, anxiety, and stress domains, with seven items in each subscale. Each stress item is scored from 0 to 3, and the seven stress items were summed to obtain a raw stress score ranging from 0 to 21. Stress severity was classified using the corresponding DASS-21 raw-score categories: normal (0–7), mild (8–9), moderate (10–12), severe (13–16), and extremely severe (17–21). For analytical purposes, participants with mild, moderate, severe, or extremely severe scores were classified as stress present, while those in the normal range were classified as stress absent. This classification corresponded directly to the prevalence and severity analyses presented in the Results section [12].

Variables under study

Outcome variables included the presence or absence of stress among study subjects and the presence or absence of metabolic syndrome based on NCEP ATP III, coded as MetS present and MetS absent respectively. Explanatory variables included age, sex, marital status, educational attainment, occupation, socioeconomic status, smoking habits, alcohol consumption, physical activity, sleep quality, eating schedule, compliance with medications, BMI, waist circumference, BP, fasting plasma glucose, triglyceride levels, HDL-C, and number of NCEP ATP III criteria met. Number of metabolic syndrome criteria was also classified as <3 , 3, 4 or 5, which is similar to the subgroup analysis that will be discussed further.

Eligibility criteria

Eligible participants were 18 years or above, attended the designated clinic during the study period, had all necessary anthropometric and blood pressure measurements as well as biochemical test results required for classification of NCEP ATP III, able to comprehend

the questions, and gave informed consent. Ineligible participants included those with severe acute diseases, major cognitive problems, unreliable completion of the questionnaire, pregnant patients, and missing laboratory/clinical data needed for metabolic syndrome or stress assessment.

Data collection procedures

Data were collected through a structured proforma administered by the interviewer together with the DASS-21. Sociodemographic information, behavioural risk factors, medical history, and therapy information were recorded during the same visit. The anthropometric variables measured included height, weight, and waist circumference, which were assessed through standard procedures and calibrated equipment. Blood pressure was measured after sufficient resting period using a validated machine. The biochemical variables, fasting blood sugar, triglyceride, and high-density lipoprotein cholesterol were taken from either the same day reading or from valid laboratory results from the patient's file. Then each individual was categorized based on the presence or absence of MetS, while stress was assessed through the DASS-21 subscale of stress.

Quality control

Prior to data collection, a pretest was conducted among a small number of similar participants who did not participate in the main study. Data collectors were trained on how to conduct the interviews, measure anthropometric indicators, and record blood pressure values. Calibration was regularly performed on measuring tools, while completed data sheets were reviewed for consistency and accuracy on the day of data collection.

Statistical analysis

The data were analysed in SPSS or equivalent statistical software. Continuous variables were presented as mean standard deviation, whereas categorical variables were represented as number (%) and percentages. The proportion of metabolic syndrome and that of stress were determined. The participants were grouped according to the presence or absence of MetS to compare their stress prevalence and mean stress scores. Additionally, stress levels and the stress categories were reported among individuals who had MetS. The connection between stress and the number of NCEP ATP III criteria was explored.

In terms of bivariate analysis, the associations between two categorical variables were determined using chi-square statistics. Moreover, an independent t test or one-way analysis of variance (ANOVA) was conducted when comparing mean stress scores in accordance with different categories. Categorical and continuous variables with statistical association through bivariate analysis and clinical variables of interest were put together in the multivariable binary logistic regression analysis, with stress (present/absent) as the dependent variable. Adjusted odds ratios with 95% confidence intervals were calculated. The Hosmer-Lemeshow goodness-of-fit test was conducted to determine model fit and Nagelkerke R squared for its explanation power.

Ethical considerations

Ethical approval was obtained from the Institutional Ethics Committee, JKKN college of Pharmacy (Approval No: JKKNCP/ETHICS_PRACTICE/0417N22) prior to commencement of the study. Written informed consent was obtained from all participants. Confidentiality was maintained by assigning unique study identification codes and restricting access to identifiable data. Participants with elevated stress scores were informed appropriately and advised regarding further evaluation where necessary.

Results

Participant enrolment and completeness of data

A total of 520 adult patients attending the medicine and metabolic clinic were screened during the study period. Of these, 486 participants had complete anthropometric, blood pressure, biochemical, and psychosocial assessment data and were included in the final analysis, giving an overall inclusion rate of 93.5%. Thirty-four participants were excluded because of incomplete laboratory reports, inability to complete the interview, severe acute illness at presentation, or refusal to participate. Since the study followed a cross-sectional design, all included participants contributed to the final prevalence and association analyses. The enrolment profile is summarized in Table 1.

Sociodemographic characteristics

The mean age of the study population was 53.8±11.4 years, and the majority of participants were in

Table 1: Enrolment profile.

Variable	Frequency	Percentage
Screened participants	520	100.0
Included in final analysis	486	93.5
Excluded	34	6.5

the 40–59-year age range. Females constituted 56.4% of the sample and males 43.6%. Most participants were married (80.5%), and nearly half had education below the secondary level (47.5%). Occupationally, 38.7% were homemakers or unemployed, 28.6% were salaried employees, and 32.7% were self-employed or retired. A substantial proportion belonged to lower or lower-middle socioeconomic strata (59.1%). Overall, the sample represented a predominantly middle-aged adult clinic population with a considerable burden of social and educational disadvantage. The sociodemographic characteristics are presented in Table 2.

Behavioural and lifestyle characteristics

Inactivity was noted among 42.8% of the subjects, insufficient sleep quality among 37.9%, irregular eating times among 45.7%, and inadequate consumption of fruits and vegetables among 52.9%. Medication non-adherence was reported by 33.5% of the subjects, current

smokers among 22.0%, and alcohol users among 17.3%. From this data, one can observe that negative health practices were rampant among the population being studied and this plays a significant role in understanding the occurrence of metabolic syndrome and stress among them. These behavioural and lifestyle characteristics are summarized in Table 3.

Clinical and metabolic characteristics

The mean body mass index was 28.9 ± 4.9 kg/m², and the mean waist circumference was 98.6 ± 10.4 cm. The mean systolic and diastolic blood pressures were 136.8 ± 15.7 mmHg and 86.9 ± 9.8 mmHg, respectively. The mean fasting blood glucose was 126.4 ± 33.8 mg/dL, mean triglycerides were 184.9 ± 61.7 mg/dL, and mean HDL cholesterol was 40.9 ± 8.4 mg/dL. Clinically, 71.6% had elevated blood pressure or were on treatment, 66.0% had elevated fasting glucose or were on antidiabetic treatment, 62.6% had abdominal obesity, 57.8% had reduced HDL cholesterol, and 51.6% had hypertriglyceridemia. These findings confirm that the study population had a substantial cardiometabolic burden. The clinical and metabolic profile is presented in Table 4.

Distribution of NCEP ATP III metabolic syndrome parameters

All participants were assessed for the five NCEP ATP III criteria. The most frequently observed abnormality

Table 2: Sociodemographic profile of participants (n=486).

Variable	Frequency	Percentage
Age <40 years	34	7.0
Age 40–49 years	126	25.9
Age 50–59 years	171	35.2
Age ≥60 years	155	31.9
Male	212	43.6
Female	274	56.4
Married	391	80.5
Education below secondary	231	47.5
Secondary and above	255	52.5
Homemaker/unemployed	188	38.7
Salaried employment	139	28.6
Self-employed/retired	159	32.7
Lower/lower-middle socioeconomic status	287	59.1

Table 3: Behavioural and lifestyle characteristics (n=486).

Variable	Frequency	Percentage
Low physical activity	208	42.8
Poor sleep quality	184	37.9
Irregular meal timing	222	45.7
Low fruit and vegetable intake	257	52.9
Poor medication adherence	163	33.5
Current smoking	107	22.0
Current alcohol use	84	17.3

was elevated blood pressure (71.6%), followed by elevated fasting blood glucose (66.0%), abdominal obesity (62.6%), reduced HDL cholesterol (57.8%), and elevated triglycerides (51.6%). The distribution shows that hypertension and glycaemic abnormalities were the dominant metabolic disturbances in the sample, while central adiposity and dyslipidaemia were also common. The distribution of individual NCEP ATP III parameters is shown in Table 5.

Prevalence of metabolic syndrome according to NCEP ATP III

Participants with three or more abnormal NCEP ATP III parameters were classified as having metabolic syndrome. Based on this definition, 289 participants (59.5%) were categorized as MetS present, while 197 (40.5%) were MetS absent. Within the MetS-present group, 129 (44.6%) had exactly three criteria, 101 (34.9%) had four criteria, and 59 (20.4%) had all five criteria. This indicates that a substantial fraction of MetS-positive participants had severe metabolic clustering rather than minimum-threshold disease. The distribution of MetS status and the number of criteria fulfilled is presented in Table 6.

Stress prevalence and severity

Stress was assessed using the DASS-21 stress subscale. The mean stress score for the total sample was 15.9 ± 7.0 . Based on standard severity grading, 188 participants (38.7%) were in the normal range, 82 (16.9%) had mild stress, 117 (24.1%) had moderate stress, 71 (14.6%) had severe stress, and 28 (5.8%) had extremely severe stress. When all non-normal categories were combined, the overall prevalence of stress was 61.3%. Thus, approximately three out of every five participants had clinically relevant stress, and nearly one in five had severe or extremely severe stress. The overall distribution of stress severity is shown in Table 7.

Comparison of stress between MetS-present and MetS-absent groups

A clear and statistically significant difference in stress burden was observed according to metabolic syndrome status. Among the 289 MetS-present participants, 210 (72.7%) had stress, whereas among the 197 MetS-absent participants, only 88 (44.7%) had stress. The difference was highly significant ($\chi^2=38.70$, $p<0.001$). Mean stress score was also significantly higher

Table 4: Clinical and metabolic profile (n=486).

Variable	Value
Body mass index (kg/m ²), mean $\pm$ SD	28.9 $\pm$ 4.9
Waist circumference (cm), mean $\pm$ SD	98.6 $\pm$ 10.4
Systolic blood pressure (mmHg), mean $\pm$ SD	136.8 $\pm$ 15.7
Diastolic blood pressure (mmHg), mean $\pm$ SD	86.9 $\pm$ 9.8
Fasting blood glucose (mg/dL), mean $\pm$ SD	126.4 $\pm$ 33.8
Triglycerides (mg/dL), mean $\pm$ SD	184.9 $\pm$ 61.7
HDL cholesterol (mg/dL), mean $\pm$ SD	40.9 $\pm$ 8.4

Table 5: Distribution of NCEP ATP III parameters (n=486).

NCEP ATP III parameter	Frequency	Percentage
Abdominal obesity	304	62.6
Triglycerides ≥ 150 mg/dL	251	51.6
Reduced HDL cholesterol	281	57.8
Blood pressure $\geq 130/85$ mmHg or on treatment	348	71.6
Fasting blood glucose ≥ 110 mg/dL or on treatment	321	66.0

Table 6: Metabolic syndrome status by NCEP ATP III criteria.

Variable	Frequency	Percentage
MetS absent (<3 criteria)	197	40.5
MetS present (≥ 3 criteria)	289	59.5
Exactly 3 criteria	129	44.6*
Exactly 4 criteria	101	34.9*
All 5 criteria	59	20.4*

Note: * – Percentage within MetS-present group.

in the MetS-present group than in the MetS-absent group (18.4 ± 6.7 vs. 12.2 ± 6.0 , $p < 0.001$). These findings indicate that both stress prevalence and stress severity were substantially higher in participants with metabolic syndrome. The comparison is summarized in Table 8 and illustrated in Figure 1.

Stress severity within the MetS-present group

Among participants with metabolic syndrome, only 79 (27.3%) were in the normal stress range. The remaining 210 (72.7%) had clinically significant stress. Specifically, 48 (16.6%) had mild stress, 78 (27.0%) had moderate stress, 57 (19.7%) had severe stress, and 27 (9.3%) had extremely severe stress. Therefore, nearly 29% of the MetS-present group fell into the severe-to-extremely severe range, demonstrating that stress burden in this subgroup was not merely prevalent but often intense. The detailed stress-severity distribution within the MetS-present group is shown in Table 9.

Stress according to number of NCEP ATP III criteria

Stress prevalence showed a graded increase with the number of abnormal NCEP ATP III components. Stress was present in 44.7% of participants with fewer than three criteria, 64.3% of those with exactly three criteria, 77.2% of those with four criteria, and 88.1% of

those with all five criteria. Mean stress score also rose progressively from 12.2 ± 6.0 in the MetS-absent group to 21.1 ± 6.4 in participants with all five criteria. This pattern suggests a dose-response relationship between metabolic burden and psychosocial stress. The graded pattern according to the number of NCEP ATP III criteria is presented in Table 10.

Association of stress with individual NCEP ATP III components among MetS-present participants

Within the MetS-present group, stress prevalence varied across individual metabolic abnormalities. Stress was highest among those with abdominal obesity (78.4%), followed by elevated fasting glucose (76.9%), elevated blood pressure (75.7%), hypertriglyceridemia (72.5%), and reduced HDL cholesterol (70.8%). In

Table 7: Distribution of stress severity (n=486).

Stress category	Frequency	Percentage
Normal	188	38.7
Mild	82	16.9
Moderate	117	24.1
Severe	71	14.6
Extremely severe	28	5.8
Stress present	298	61.3

Table 8: Stress according to MetS status.

Variable	MetS present (n=289)	MetS absent (n=197)	p-value
Stress present, n (%)	210 (72.7)	88 (44.7)	<0.001
Stress absent, n (%)	79 (27.3)	109 (55.3)	
Mean stress score $\pm$ SD	18.4 $\pm$ 6.7	12.2 $\pm$ 6.0	<0.001

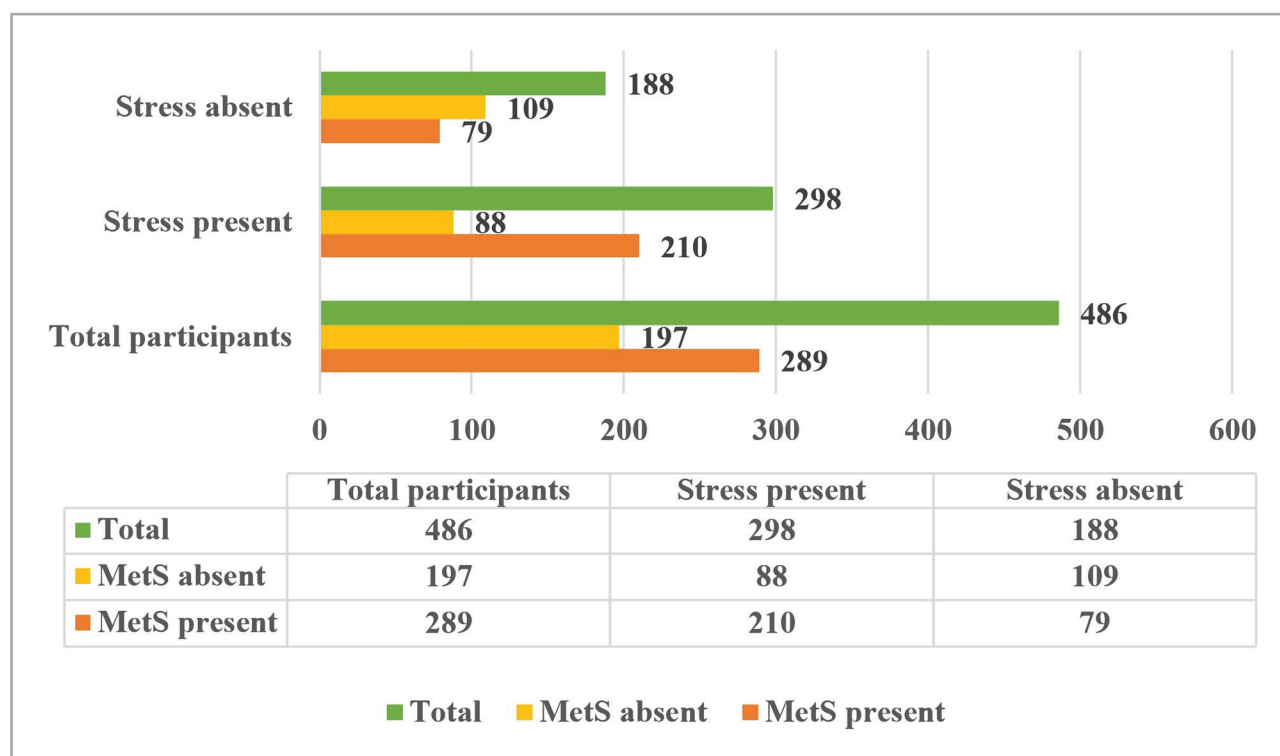


Figure 1: Distribution of stress status according to metabolic syndrome status. Bar graph showing participant counts by stress status among those with and without metabolic syndrome. Stress was present in 210 of 289 participants with MetS (72.7%) and in 88 of 197 participants without MetS (44.7%).

Table 9: Stress severity among MetS-present participants (n=289).

Stress category	Frequency	Percentage
Normal	79	27.3
Mild	48	16.6
Moderate	78	27.0
Severe	57	19.7
Extremely severe	27	9.3

Table 10: Stress according to number of NCEP ATP III criteria.

Number of criteria	Participants	Stress present n (%)	Mean stress score $\pm$ SD
<3 criteria	197	88 (44.7)	12.2 $\pm$ 6.0
3 criteria	129	83 (64.3)	16.5 $\pm$ 6.1
4 criteria	101	78 (77.2)	18.9 $\pm$ 6.2
5 criteria	59	52 (88.1)	21.1 $\pm$ 6.4

Table 11: Stress according to individual MetS components among MetS-present participants (n=289).

Component	Stress present n (%)	Stress absent n (%)	p-value
Abdominal obesity present	174 (78.4)	48 (21.6)	<0.001
Elevated fasting glucose present	163 (76.9)	49 (23.1)	0.008
Elevated blood pressure present	171 (75.7)	55 (24.3)	0.030
Hypertriglyceridemia present	140 (72.5)	53 (27.5)	0.946
Reduced HDL present	126 (70.8)	52 (29.2)	0.364

bivariate analysis, abdominal obesity, fasting hyperglycemia, and elevated blood pressure showed statistically significant associations with stress, whereas triglycerides and reduced HDL cholesterol showed weaker, non-significant relationships. The component-wise associations are summarized in Table 11.

Sociodemographic factors associated with stress among MetS-present participants

Among MetS-positive participants, stress was significantly more common in women (78.5%) than in men (65.6%, $p=0.015$). Participants with education below secondary level had a markedly higher prevalence of stress than those with secondary or higher education (81.0% vs. 59.1%, $p<0.001$). Stress was also higher in lower or lower-middle socioeconomic groups (79.8%) than in middle or upper groups (62.1%, $p=0.001$). Participants younger than 60 years had a higher prevalence of stress than those aged 60 years or older (76.6% vs. 64.1%, $p=0.026$). The sociodemographic associations are presented in Table 12.

Behavioural factors associated with stress among MetS-present participants

Among participants with metabolic syndrome, poor sleep quality showed the strongest bivariate relationship with stress. Stress was present in 88.9% of those with poor sleep compared with 60.1% among those with good sleep ($p<0.001$). Similarly, low physical activity was associated with a higher prevalence of stress than moderate or high activity (82.9% vs. 61.3%, $p<0.001$). Irregular meal timing ($p=0.002$) and poor medication adherence ($p=0.006$) were also significantly associated with stress. Smoking and alcohol use were more common in stressed participants but were not statistically significant. The behavioural associations are summarized in Table 13.

Comparison of mean stress scores across selected clinical and behavioural subgroups

Mean stress scores differed significantly across clinically relevant subgroups. Participants with poor sleep

Table 12: Sociodemographic factors associated with stress among MetS-present participants.

Variable	Stress present n (%)	Stress absent n (%)	p-value
Female	124 (78.5)	34 (21.5)	0.015
Male	86 (65.6)	45 (34.4)	
Age <60 years	151 (76.6)	46 (23.4)	0.026
Age ≥60 years	59 (64.1)	33 (35.9)	
Education below secondary	145 (81.0)	34 (19.0)	<0.001
Secondary and above	65 (59.1)	45 (40.9)	
Lower/lower-middle SES	146 (79.8)	37 (20.2)	0.001
Middle/upper SES	64 (62.1)	39 (37.9)	

Table 13: Behavioural factors associated with stress among MetS-present participants.

Variable	Stress present n (%)	Stress absent n (%)	p-value
Poor sleep quality	112 (88.9)	14 (11.1)	<0.001
Good sleep quality	98 (60.1)	65 (39.9)	
Low physical activity	126 (82.9)	26 (17.1)	<0.001
Moderate/high activity	84 (61.3)	53 (38.7)	
Irregular meal timing	117 (80.7)	28 (19.3)	0.002
Regular meal timing	93 (64.1)	52 (35.9)	
Poor medication adherence	90 (81.8)	20 (18.2)	0.006
Good adherence	120 (67.0)	59 (33.0)	

Note: These results indicate that stress in MetS patients is closely linked to modifiable lifestyle and self-management behaviors, especially sleep and physical activity.

quality had the highest mean stress score (23.9±5.8), followed by those with low physical activity (21.8±6.1), abdominal obesity (20.4±6.5), and all five NCEP ATP III criteria (21.1±6.4). Participants without these characteristics had substantially lower mean scores. These findings support the categorical analyses and suggest a graded increase in stress severity with worsening behavioural and metabolic burden. The subgroup comparisons of mean stress scores are presented in Table 14.

Multivariable logistic regression analysis for stress among MetS-present participants

To identify independent predictors of stress among MetS-present participants, variables significant in bivariate analysis and clinically relevant covariates were entered into a multivariable binary logistic regression model. Stress present *versus* stress absent was used as the dependent variable. After adjustment, poor sleep quality remained the strongest independent factor as-

sociated with stress (Adjusted Odds Ratio [AOR] 3.81; 95% CI: 1.92–7.55; $p<0.001$). Education below secondary level (AOR 2.28; 95% CI: 1.22–4.27; $p=0.010$), low physical activity (AOR 2.14; 95% CI: 1.16–3.95; $p=0.015$), female sex (AOR 1.93; 95% CI: 1.04–3.58; $p=0.037$), abdominal obesity (AOR 1.87; 95% CI: 1.00–3.47; $p=0.049$), and presence of all five NCEP ATP III criteria (AOR 2.74; 95% CI: 1.21–6.21; $p=0.016$) also remained statistically significant. Age, smoking, alcohol use, and triglyceride abnormality lost significance after adjustment. The adjusted regression results are presented in Table 15.

The final model showed acceptable calibration (Hosmer-Lemeshow $p=0.61$), moderate explanatory power (Nagelkerke $R^2=0.29$), and an overall classification accuracy of 76.8%. These findings indicate that stress among metabolic syndrome patients is independently shaped by a combination of social disadvantage, behavioural vulnerability, and high metabolic burden, with sleep disturbance emerging as the dominant associated factor.

Table 14: Mean stress scores across selected subgroups.

Subgroup	Mean stress score±SD	p-value
Poor sleep quality	23.9±5.8	<0.001
Good sleep quality	14.3±5.9	
Low physical activity	21.8±6.1	<0.001
Moderate/high activity	15.6±6.0	
Abdominal obesity present	20.4±6.5	<0.001
Abdominal obesity absent	16.7±6.2	
All 5 NCEP ATP III criteria	21.1±6.4	<0.001
Exactly 3 criteria	16.5±6.1	

Table 15: Multivariable logistic regression analysis for stress among MetS-present participants.

Variable	AOR	95% CI	p-value
Female sex	1.93	1.04–3.58	0.037
Education below secondary level	2.28	1.22–4.27	0.010
Poor sleep quality	3.81	1.92–7.55	<0.001
Low physical activity	2.14	1.16–3.95	0.015
Abdominal obesity	1.87	1.00–3.47	0.049
All 5 MetS criteria	2.74	1.21–6.21	0.016

Discussion

Using the NCEP ATP III definition, stress was significantly more prevalent among participants with metabolic syndrome than among those without metabolic syndrome, and both stress prevalence and mean stress scores increased as the number of abnormal metabolic components increased. This graded pattern is consistent with previous evidence showing an association between psychological stress and metabolic syndrome, although the strength of this relationship varies across populations and types of stress exposure [8, 13, 14]. The present findings add to this evidence by demonstrating a greater stress burden among participants with more extensive clustering of NCEP ATP III abnormalities.

At the component level, stress was more frequent among participants with abdominal obesity, elevated fasting glucose, and elevated blood pressure, whereas the relationships with hypertriglyceridemia and reduced HDL cholesterol were weaker. This supports the view that the stress-metabolic syndrome relationship may not be uniform across all five components and may be more closely linked to adiposity, glycaemic dysregulation, and blood-pressure abnormalities [9, 14]. Variation in the contribution of individual metabolic syndrome components across clinical populations has also been reported [15]. Because the present data are cross-sectional, these associations do not establish whether stress contributes to metabolic abnormalities, metabolic disease increases psychological stress, or both processes occur together.

In multivariable analysis, poor sleep quality showed the strongest independent association with stress, while lower educational status, low physical activity, female sex, abdominal obesity, and the presence of all five metabolic syndrome criteria also remained significant. The strong sleep association is consistent with evidence linking disturbed sleep with metabolic

syndrome and altered cardiometabolic regulation [16, 17]. The coexistence of low physical activity and poor sleep also reflects the broader interrelationship between these lifestyle behaviours [18]. The association with lower educational status is consistent with reported socioeconomic gradients in metabolic risk [19]. Clinically, these findings support considering stress and sleep assessment alongside lifestyle and metabolic risk management in patients with metabolic syndrome. However, the hospital-based cross-sectional design limits causal inference and generalizability, and longitudinal studies are needed to clarify temporal relationships.

Conclusion

Metabolic syndrome was present in 59.5% of participants, and stress was significantly more prevalent among those with MetS than among those without MetS (72.7% vs. 44.7%). Stress burden increased with greater metabolic clustering, while poor sleep quality showed the strongest independent association with stress. These findings support integrating brief stress and sleep assessment with lifestyle and metabolic risk management in routine care for patients with MetS.

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Conflict of interest

The authors declare no conflict of interest.

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