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Depression among medical students and the role of academic stress and coping strategies: a cross-sectional study in Bangladesh

Abstract

Objectives: Depression is highly prevalent among medical students, especially in resource-constrained settings like Bangladesh, where academic stress serves as a prominent contributing factor. This study aims to explore the predictors of depression among medical students, with a specific focus on academic stress and coping mechanisms, while also evaluating the influence of behavioral and sociodemographic factors on depression in Bangladeshi medical students.

Methods: This cross-sectional study, conducted from October to December 2022, involved 1,072 undergraduate medical students from six public medical colleges in Bangladesh, selected through simple random sampling. Depression was measured using the PHQ-9, while academic stress, anxiety, insomnia, self-esteem, coping strategies, and internet addiction were assessed using the ASS-40, GAD-7, ISI, RSES, SCSI, and IAT, respectively. Data were analyzed by SPSS and Jamovi software employing chi-square tests, Mann–Whitney U tests, and binary logistic regression. The predicted probabilities were presented as beta coefficients, including crude and adjusted odds ratios (AOR), 95 % confidence intervals, and p-values.

Results: Over half of the participants experienced moderate to severe depression. Key predictors of depression included academic stress, coping strategies, and various sociodemographic and behavioral factors. Inadequate study facilities (OR: 1.32, 95 % CI: 1.21–1.44) and feelings of personal inadequacy (OR: 1.33, 95 % CI: 1.23–1.43) significantly increased the likelihood of depression. Among coping strategies, passive problem-focused coping was associated with higher odds of depression (OR: 1.17, 95 % CI: 1.08–1.26), whereas passive emotion-focused coping slightly reduced the risk (OR: 0.91, 95 % CI: 0.85–0.98). Active emotional coping had a marginal effect (OR: 1.07, 95 % CI: 1.00–1.15). Sociodemographic factors also played a significant role. Females were less likely to experience depression than males (OR: 0.35, 95 % CI: 0.19–0.68), and urban residents had lower odds than rural counterparts (OR: 0.40, 95 % CI: 0.19–0.86). Higher paternal education was protective (OR: 0.09, 95 % CI: 0.04–0.21), while maternal education beyond the secondary level was linked to increased risk (OR: 4.07, 95 % CI: 1.61–10.33). Among behavioral factors, insomnia significantly increased the odds of depression (OR: 1.38, 95 % CI: 1.29–1.48), while moderate internet use showed a protective effect compared to no use (OR: 0.26, 95 % CI: 0.13–0.52). Anxiety emerged as a strong predictor (OR: 1.78, 95 % CI: 1.61–1.97). Economically, having a personal income reduced the risk of depression by 49 % (OR: 0.51, 95 % CI: 0.27–0.96).

Conclusions: Depression among medical students is significantly associated with academic stress, ineffective coping strategies, insomnia, and anxiety, which may further intensify among high-risk groups such as males, rural residents, and those facing financial challenges. Effective interventions should focus on reducing stress, developing adaptive coping skills, ensuring equitable access to academic resources, and enhancing mental health screening and support services.

Keywords: depression; academic stress; stress-coping; anxiety; insomnia; medical students

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Background

Depression is a prevalent mental health disorder and a leading global cause of disability, impairing the well-being of over 280 million people [1]. Medical students are a particularly vulnerable group, exhibiting elevated prevalence rates – reported between 39 and 59 % among Bangladeshi medical students – which exceed those in the general population [2, 3]. This heightened susceptibility is largely attributable to the intense academic environment, including rigorous workloads, prolonged study hours, sleep deprivation, and significant pressure to succeed [4, 5].

Academic stress is a well-established major predictor of depressive symptoms in this population [6, 7]. The resulting psychological distress often manifests as emotional exhaustion, helplessness, and persistent sadness [7]. Compounding this stress, factors such as inadequate study facilities and feelings of personal inadequacy can further increase depression risk [8].

How students manage this stress is critical. According to Lazarus and Folkman's transactional model, individuals employ different coping strategies, broadly categorized as problem-focused coping (aimed at addressing the stressor) or emotion-focused coping (aimed at regulating emotional response) [9, 10]. Empirical studies consistently indicate that adaptive coping strategies, such as active problem-solving and social support-seeking behaviors, are associated with a lower risk of depression. Conversely, maladaptive strategies, such as avoidance, denial, or disengagement – often mischaracterized as "passive problem-focused" – are strongly associated with increased depressive symptoms [11–13].

Behavioral factors also play a significant role. Sleep disturbances are common and closely linked to depression. While medical students commonly use the internet for academic, professional, and knowledge-seeking purposes, excessive use may lead to internet addiction, which is linked to academic disengagement, depression, and insomnia. In contrast, moderate use can support psychological well-being by fostering academic support, social connectedness, and relaxation, whereas overuse and addiction pose significant risks to mental health [14]. Additionally, it is well established that anxiety disorders often co-occur with depression, and high anxiety levels significantly increase the risk of depression [15].

Several sociodemographic factors influence susceptibility. Female medical students frequently reported higher levels of academic stress [16] and, in some studies, higher depression rates compared to males, potentially reflecting differences in coping styles or reporting [17–19]. Students migrating from rural backgrounds often face specific challenges, such as cultural adjustment difficulties, reduced access to familiar support networks, or resource limitations, contributing to greater psychological distress [20, 21].

Studies have identified financial stability, associated with reduced stress and enhanced mental well-being [21–24], along with strong social support networks as key resilience factors. In addition to active coping strategies, self-esteem, and institutional and social support, factors such as parental education and family support play a supporting role in fostering psychological resilience; however, higher maternal education may at times be associated with greater academic pressure [25–27].

Despite this evidence, research comprehensively examining the interplay of academic stress, coping strategies, sleep quality, anxiety, and sociodemographic factors as predictors of depression specifically among Bangladeshi medical students remains limited. This study aims to address this gap by investigating these key predictors, with a particular focus on the roles of academic stress and coping mechanisms. The findings will inform targeted interventions to enhance the mental well-being of this critical student group.

Method and sampling

Study design and sampling

This cross-sectional study was conducted from October 1 to December 30, 2022, among undergraduate medical students from six purposively selected public medical colleges in Bangladesh. These institutions were chosen from the country's 37 public medical colleges to ensure proportional geographic representation across all six administrative divisions – Manikganj Medical College (MkMC) in Dhaka, Cumilla Medical College (CMC) in Chattogram, Shaheed M. Monsur Ali Medical College (SMMAMC) in Rajshahi, Khulna Medical College (KMC) in Khulna, Patuakhali Medical College (PkMC) in Barishal, and Habiganj Medical College (HMC) in Sylhet – with one college selected from each divisional headquarters. We employed a stratified random sampling approach, first stratifying by academic year (first through fifth) and gender to ensure proportional representation, then randomly selecting students within each academic year stratum using computer-generated random numbers applied to complete class rolls (the sampling frame), thus confirming equal selection probability. The required sample size was calculated using *"Epitools"* epidemiological software, with the following parameters: an anticipated depression prevalence of 39.1 % drawn from previous literature [4], a 95 % confidence interval, a 3 % margin of error,

and a design effect of 1.0. This calculation yielded a minimum sample size requirement of 981 participants. Accounting for a 10 % anticipated non-response rate, we increased the target to 1,080 participants, achieved by randomly selecting 36 students per academic year from each institution (5 years × 36=180 per college × 6 colleges=1,080 total). Following data collection, rigorous quality checks excluded incomplete/inconsistent responses, yielding 1,072 valid questionnaires for analysis. Manikganj Medical College (MkMC) in the Dhaka Division fell short by four samples compared to the estimated target, two missing from first-year students and two from fifth-year students. Similarly, Habiganj Medical College (HMC) in the Sylhet Division lacked four samples from fourth-year students due to incomplete or inconsistent data. Data from the other medical colleges across the remaining four divisions were found to be complete and satisfactory. While all enrolled undergraduates were eligible, we excluded those who declined informed consent or were absent due to illness during the data collection process.

Data collection and research instrument

Data were collected using a pre-tested, structured questionnaire in Bengali, which was translated and back-translated by bilingual experts to ensure linguistic accuracy. The self-administered interview questionnaire consisted of 132 items organized into eight sections, including socio-demographic information and various validated psychiatric and behavioral measurement scales. Socio-demographic variables included age, gender, place of residence (urban or rural), relationship status, parents' education level, monthly family income, and religion. For the psychiatric assessment, depression was evaluated using the Patient Health Questionnaire-9 (PHQ-9), academic stress was measured with the Academic Stress Scale (ASS-40), anxiety was assessed via the Generalized Anxiety Disorder-7 (GAD-7), insomnia severity was gauged using the Insomnia Severity Index (ISI), and self-esteem was examined with the Rosenberg Self-Esteem Scale (RSES). To assess behavioral responses, we utilized the Stress Coping Style Inventory (SCSI) to measure problem-focused and emotion-focused coping strategies, and the Internet Addiction Test (IAT) to evaluate problematic internet use among participants. Except for the SCSI, nearly all the scales have been extensively employed, are available in validated Bengali versions, and exhibit strong cross-cultural applicability. A comprehensive overview of their psychometric properties justifying their use in the research is provided in Supplementary Table 1. Participants completed the survey in approximately 25 min.

Patient Health Questionnaire-9 (PHQ-9): The Patient Health Questionnaire-9 (PHQ-9) is an empirically validated self-report tool aligned with DSM-IV criteria for depression. A cut-off score of ≥10 yields 88 % sensitivity and specificity for major depression compared to clinical interviews, ensuring strong detection accuracy while minimizing false positives. Due to its robust validation and practicality, the PHQ-9 is an appropriate choice for assessing probable depression in this research [28].

Academic Stress Scale (ASS-40): This 40-item scale, initially developed by Kim (1970) and later adapted for the Indian context by Rajendran & Kaliappan (1990), measures five core dimensions of academic stress: personal inadequacy, fear of failure, interpersonal challenges with teachers, teacher-student dynamics/instructional methods, and insufficient study facilities. A validated cut-off score of ≥67.13 indicates clinically significant academic stress. In this study, individuals scoring above 67 were classified as experiencing academic stress, while those below 67 were considered to have no stress. Higher scores indicate higher levels of academic stress. Recent mixed-methods research involving medical and dental students (aged 18–25) in Peshawar, Pakistan, demonstrated acceptable internal consistency (Cronbach's α=0.70) and high test-retest reliability (r=0.82), supporting the validity of this measure as a reliable indicator of academic stress in the present study [29].

Generalized Anxiety Disorder-7 (GAD-7): The Bangla version of the GAD-7 has undergone validation for use with Bangladeshi populations, particularly university students, confirming its cultural and linguistic suitability for evaluating anxiety symptoms in Bangladeshi medical students. With only seven items, public accessibility, and straightforward scoring methodology, this instrument is particularly well-suited for extensive research applications, establishing it as an efficient measure for studying academic stress in medical education environments [30].

Insomnia Severity Index (ISI): The Bangla adaptation of the Insomnia Severity Index (ISI) has been psychometrically validated for use in Bangladesh, showing consistent measurement properties across gender, depression status, and suicidal ideation. Demonstrating strong concurrent validity through its association with depression scores (PHQ-9, r=0.58), the ISI-Bangla serves as an effective tool for evaluating insomnia severity and is appropriate for population-level screening among Bangladeshi medical students [31].

Rosenberg Self-Esteem Scale (RSES): The Bangla version of the Rosenberg Self-Esteem Scale (RSES) has been comprehensively validated for use in Bangladesh, showing excellent psychometric characteristics (Akhter and Ferdous 2019). Demonstrating strong construct validity, the

instrument reliably identifies gender-based variations while showing positive correlations with state self-esteem and negative associations with social anxiety. Originally validated on Bangladeshi university students (mean age=21.17 years), its applicability extends to medical students given their similar educational and demographic profiles [32].

Stress Coping Style Inventory (SCSI): Lazarus and Folkman's transactional model (1984) describes stress as a dynamic psychological process where individuals constantly evaluate environmental challenges in relation to their perceived coping abilities. This model comprises two critical appraisal phases: (1) primary appraisal (threat identification) and (2) secondary appraisal (coping option assessment). Coping mechanisms can be categorized into two types: problem-focused strategies, which aim directly to tackle stressors, and emotion-focused strategies, which focus on managing emotional responses. The effectiveness of coping depends on how well the chosen strategy aligns with the specific stressor at hand [9, 10].

The 28-item Stress Coping Scale Inventory (SCSI) operationalizes this theoretical framework through four distinct dimensions: active emotional, passive emotional, active problem-focused, and passive problem-focused coping. While cultural adaptation for Bangladeshi populations is still in progress, its thorough evaluation of problem-solving strategies and emotional regulation closely aligns with universal challenges in medical education. These challenges include demanding academic workloads, high-stakes examinations, and clinical responsibilities, making this assessment especially valuable for understanding coping mechanisms in the rigorous environment of medical training [33].

Internet Addiction Test (IAT): The Bangla-adapted Internet Addiction Test (IAT), initially developed by Young (1996), assesses four key dimensions: Neglect of Duty, online Dependence, Virtual Fantasies, and Privacy/Self-Defense. Notably, the Neglect of Duty subscale demonstrates strong relevance to academic impairment – a significant concern for medical students. Given their rigorous academic workload, extensive internet use, and elevated stress levels, medical students in Bangladesh represent a high-risk population for problematic internet use. As a culturally validated, freely accessible, and psychometrically robust self-report measure, the IAT serves as a practical tool for large-scale screening in resource-constrained educational environments [34].

Ethical statement

The study received formal approval from the Institutional Review Board and the Patuakhali Medical College Research Ethics Committee (PkMC-REC-2023-08-17/SR79). Written consent was obtained from all participants after they were informed of the study's objectives and their right to participate voluntarily. The research adhered to the ethical guidelines outlined in the Declaration of Helsinki, ensuring the privacy, confidentiality, and anonymity of participants. Personally identifiable information was kept confidential, and the study's results would be shared for public benefit only.

Statistical analysis

The data were cleaned and processed in SPSS version 23.0, while multivariate analyses and graphical presentations were performed using Jamovi version 2.6.44.

Descriptive statistics: Participants were stratified into two groups using the validated PHQ-9 cutoff score of ≥10 (demonstrating 88 % sensitivity and specificity for major depression against structured clinical interviews), distinguishing between those with and without clinically significant depressive symptoms [28]. All other psychiatric and behavioral measures were classified based on their validated cutoff thresholds [Supplementary Table 1]. The descriptive and inferential data were illustrated through tables and graphs.

Bivariate analysis: We evaluated the normality of continuous variables through multiple approaches, including skewness and kurtosis analysis, Shapiro-Wilk and Anderson-Darling tests, and visual inspection of Q-Q and distribution plots. The quantitative variables designated for analysis in the study exhibited a non-normal distribution. Consequently, bivariate analyses were conducted using the Mann-Whitney U test for continuous/ordinal variables and chi-square (χ^2) tests for categorical variables to assess associations between academic stress, coping strategies, key psychosocial factors, and depression in medical students.

Multivariate analysis: To identify significant predictors while accounting for confounding factors, a binary logistic regression model included all explanatory variables that showed a significant association in univariate and bivariate analyses (p<0.05). The predictive accuracy, goodness-of-fit, explained variance, classification accuracy, Area Under the Curve (AUC), and Multicollinearity diagnostics were reported to support the validity of the regression model. The predicted probabilities were presented as beta coefficients, the Crude and Adjusted Odds Ratios (AOR), including 95 % confidence intervals (CI), and p values.

Results

A total of 1,072 undergraduate medical students from six public medical colleges in Bangladesh were included in the final analysis. Of these, 409 (38.2 %) were male, and 663 (61.8 %) were female, with females outnumbering males across all institutions. Overall, female representation ranged from 59 to 66 %, while male representation ranged from 34 to 41 %. Institutional participation was evenly distributed, with 176 students each from Manikganj Medical College (MkMC) and Habiganj Medical College (HMC), and 180 students each from Cumilla Medical College (CMC), Shaheed M. Monsur Ali Medical College (SMMAMC), Khulna Medical College (KMC), and Patuakhali Medical College (PkMC). Representation across academic years was also balanced, comprising 214 first-year, 216 s-year, 216 third-year, 212 fourth-year, and 214 fifth-year students. This distribution provides a well-rounded sample, reflecting diversity in gender, academic standing, and geographic coverage.

The prevalence of depression did not vary significantly across the six medical colleges. As shown in Table 1, the Pearson chi-square test revealed no statistically significant association between college location and depressive symptoms among students (χ^2=1.692, df=5, p=0.890). This suggests that depressive symptoms remained fairly consistent across all participating institutions, regardless of location. In contrast, a significant link was found between academic year and depression. Table 1 shows that the prevalence of depressive symptoms varied significantly across academic years, with substantially higher rates observed among fourth- and fifth-year students and the lowest among third-year students (χ^2=90.093, df=4, p<0.001). This gradient suggests that the escalating clinical workload and academic demands in the later phases of Bangladesh's medical curriculum may meaningfully contribute to increased psychological distress.

Sociocultural influences

This multi-center cross-sectional study investigated associations between academic stress, coping strategies, depression, and sociodemographic/behavioral factors among Bangladeshi medical students. Depression prevalence was 47.4 % (509/1,072). Sex demonstrated borderline statistical significance with depression (p=0.051), with males reporting higher rates (49.4 %, 202/409) than females (43.3 %, 287/663). A robust association emerged between religious affiliation and depression status (χ^2=42.86, p<0.001; Cramér's V=0.20). Maternal education was significantly linked to depression status (χ^2=13.45, p<0.001), whereas paternal education (p=0.953), personal income (p=0.645), and marital status (p=0.844) showed no significant relationships.

Living arrangements significantly predicted depression: Students cohabiting with family exhibited a higher prevalence (57.3 %, 164/286) than those living with peers (41.3 %, 325/786; χ^2=21.62, p<0.001). Similarly, non-dormitory residents reported substantially elevated depression rates (76.5 %, 39/51) compared to dormitory occupants (44.1 %, 450/1,021; χ^2=20.55, p<0.001; both Cramér's V=0.14). Rural residence was associated with moderately higher depression prevalence (55.2 %) vs. urban dwellers (44.1 %; χ^2=5.77, p=0.016). [Table 2].

Table 1: Proportion of depression by institution and academic year among study participants (n=1,072).

Characteristics		Depression		Total		
		Absent n (%)	Present n (%)	N (%)	χ2, df	p-Value
Medical college (division)	Manikganj medical college, MkMC (Dhaka)	95 (54)	81 (46)	176 (100)	1.69 (5)	0.89
	Cumilla medical college CMC (Chattogram)	103 (57.2)	77 (42.8)	180 (100)		
	Shaheed M Monsur ali medical college SMMAMC (Rajshahi)	93 (51.7)	87 (48.3)	180 (100)		
	Khulna medical college KMC (Khulna)	99 (55)	81 (45)	180 (100)		
	Patuakhali medical college PkMC (Barisal)	101 (56.1)	79 (43.9)	180 (100)		
	Habiganj medical college HMC (Sylhet)	92 (52.3)	84 (47.7)	176 (100)		
Academic year	First year	127 (59.3)	87 (40.7)	214 (100)	90.09 (4)	[a]<0.001
	Second year	116 (53.7)	100 (46.3)	216 (100)		
	Third year	170 (78.7)	46 (21.3)	216 (100)		
	Fourth year	88 (41.5)	124 (58.5)	212 (100)		
	Fifth year	82 (38.3)	132 (61.7)	214 (100)		

[a]The Chi-square test indicates a statistically significant result at the 0.05 level,

Table 2: Distribution of depression by sociodemographic factors (n=1,072).

Characteristics	Categories	Depression		Total	^{b}Effect size		
		Absent n (%)	Present n (%)	N (%)	χ2, df	p-Value	Phi (φ)/Cramér's V (V)
Sex	*Male*	207 (51)	202 (49)	409 (100)	3.79 (1)	^{a}0.051	(φ)=0.06
	Female	376 (57)	287 (43)	663 (100)			
Religion	*Islam*	545 (58)	392 (42)	937 (100)	42.86 (1)	^{a}<0.001	**(φ)=0.20**
	Hinduism	38 (28)	97 (72)	135 (100)			
Mother's education	*Below SSC*	37 (37)	63 (63)	100 (100)			
	SSC or Equivalent	284 (56)	220 (44)	504 (100)	13.45 (2)	^{a}<0.001	**V=0.11**
	HSC and above or equivalent	262 (56)	206 (44)	468 (100)			
Father's education	*Below SSC*	36 (56)	28 (44)	64 (100)			
	SSC or Equivalent	6 (55)	5 (45)	11 (100)	0.10 (2)	0.953	**V=0.01**
	HSC and above or equivalent	541 (54)	456 (46)	997 (100)			
Personal income	*No*	490 (54)	416 (46)	906 (100)	0.211 (1)	0.645	(φ)=0.01
	Yes	93 (56)	73 (44)	166 (100)			
Living area	*Rural*	69 (45)	83 (55)	152 (100)	5.77 (1)	^{a}0.016	(φ)=0.07
	Urban	514 (56)	406 (44)	920 (100)			
Living with	*Friends*	461 (100)	325 (41)	786 (100)	21.62 (1)	^{a}<0.001	**(φ)=0.14**
	Family	122 (43)	164 (57)	286 (100)			
Living in a dormitory	*No*	12 (24)	39 (76)	51 (100)	20.55 (1)	^{a}<0.001	**(φ)=0.14**
	Yes	571 (56)	450 (44)	1,021 (100)			
Marital status	*Unmarried*	564 (54)	472 (46)	1,036 (100)	0.04 (1)	0.844	(φ)=0.01
	Married	19 (53)	17 (47)	36 (100)			

^{a}The Chi-square test indicates a statistically significant result at the 0.05 level, ^{b}Effect sizes were assessed using **Phi (φ)** for 2 × 2 tables and **Cramer's V (V)** for larger tables. Following Cohen (1988), φ values of 0.10, 0.30, and 0.50 and V values of 0.07, 0.21, and 0.35 (for df=2) denote small, medium, and large effects, respectively.

Psychological and behavioral vulnerabilities of depression

Depression is significantly linked to anxiety, academic stress, insomnia, and internet addiction among medical students. Students with severe anxiety were significantly more likely to report depressive symptoms than those with minimal anxiety (χ^2=386.36, p<0.001) and a large effect size (Cramér's V=0.60).

Academic stress demonstrated a moderate association with depression prevalence: students experiencing significant academic stress were three times more likely to report depressive symptoms than their non-stressed counterparts (75 vs. 25 %; χ^2=156.32, p<0.001, φ=0.38). A striking dose-response relationship emerged for insomnia severity, where depression prevalence escalated from 25 % in non-clinical cases to 100 % among students with severe insomnia (χ^2=257.36, p<0.001, V=0.49). Internet addiction further predicted depression risk with a significant association strength (χ^2=132.22, p<0.001, V=0.35). While self-esteem showed no significant categorical association with depression (χ^2=1.69, p=0.193), depressed students exhibited substantially lower continuous self-esteem scores (Mann-Whitney U=126,412.50; p<0.001; r=−0.14), revealing an inverse relationship. Depressed students further demonstrated striking elevations in anxiety (U=40,644.50; p<0.001; r=0.71), insomnia severity (U=55,732.00; p<0.001; r=0.61), and internet addiction (U=91,877.00; p<0.001; r=0.36) – with effect sizes ranging from moderate to large. All dimensions of academic stress – spanning inadequate facilities, strained teacher-student relationships, perceived personal inadequacy, sub-optimal teaching methods, and fear of failure – demonstrated consistent positive associations with depression severity. Students having depression further exhibited significantly greater reliance on passive coping strategies, with notably elevated passive emotional coping (U=104,837; p<0.001; r=0.26) and passive problem-focused coping (U=117,780; p<0.001; r=0.17), reflecting small-to-medium effect sizes indicative of less adaptive response patterns [Table 3].

Figure 1 presents the psychosocial differences between depressed and non-depressed students. Compared to their non-depressed counterparts, depressed students reported markedly higher levels of academic stress (r=−0.54), anxiety (r=−0.71), and insomnia severity (r=−0.61). In contrast, their self-esteem scores were slightly lower, with a small effect size (r=−0.11).

Figure 2 illustrates the median variations across five categories of depression severity. The upper panel shows that median scores for academic stress subscales increased progressively with greater depression severity, particularly

Table 3: Psychological and behavioral factors of academic stress among medical students (n=1,072).

Characteristics	Categories	[a]Depression status (based on PHQ-9 cut-off)			[e]Effect size		
		Absent n (%)	Present n (%)	Total N (%)	χ^2, df	p-Value	Phi (φ)/Cramér's V (V)
Anxiety	Minimal	165 (91)	16 (9 %)	181 (100)			
	Mild	288 (77)	88 (23)	376 (100)	386.36 (3)	[b]<0.001	**V=0.60**
	Moderate	96 (39)	149 (61)	245 (100)			
	Severe	34 (13)	236 (87)	270 (100)			
Academic stress	Absent	408 (72)	155 (28)	563 (100)	156.32 (1)	[b]<0.001	**(φ)=0.38**
	Present	175 (34)	334 (66)	509 (100)			
Insomnia	No clinically significant	305 (75)	100 (25)	405 (100)			
	Subthreshold	242 (60)	163 (40)	405 (100)	257.36 (3)	[c]<0.001	**V=0.49**
	Clinically significant, moderately severe	36 (18)	160 (82)	196 (100)			
	Clinically significant severe	0 (0)	66 (100)	66 (100)			
Internet addiction	Not significant	361 (72)	143 (28)	504 (100)			
	Mild	101 (31)	220 (69)	321 (100)	132.22 (3)	[b]<0.001	**V=0.35**
	Moderate	120 (49)	123 (51)	243 (100)			
	Severe	1 (25)	3 (75)	4 (100)			
Self-esteem	Low	176 (58)	130 (42)	306 (100)	1.69 (1)	0.193	**(φ)=0.04**
	Normal to high	407 (53)	359 (47)	766 (100)			

Total scores of psychological and behavioral factors	[a]Depression status (based on PHQ-9 cut-off)				Mann-Whitney U Test statistic	p-Value	[e]Effect size
	Absent (n=489)		Present (n=583)				Rank biserial correlation
	Median	IQR	Median	IQR			
Anxiety	7	5	14	8	40,644.50	[d]<0.001	**0.71**
Insomnia	7	6	14	8	55,732.00	[d]<0.001	**0.61**
IAT	23	28	45	24	91,877.00	[d]1<0.001	**0.36**
Self-esteem	15	3	16	4	126,412.50	[d]0.0012	**0.11**
Inadequate study facilities	11	8	16	6	72,363.50	[d]<0.001	**0.49**
Teacher-pupil relationship	12	8	16	7	82,206.50	[d]<0.001	**0.42**
Personal inadequacy	12	8	15	8	77,683.00	[d]<0.001	**0.46**
Teaching method	10	8	14	9	94,468.50	[d]<0.001	**0.34**
Fear of failure	10	7	15	7	78,581.50	[d]<0.001	**0.45**
Active emotional coping	30	6	29	6	132,241.00	[d]0.0407	−0.07
Passive emotional coping	15	6	16	6	104,837.00	[d]<0.001	**0.26**
Active problem coping	22	4	22	5	135,045.50	0.135	−0.05
Passive problem coping	21	5	22	7	117,780.00	[d]<0.001	**0.17**

[a]**Depression classified as PHQ-9≤9=No depression; PHQ-9≥10=Depression.** [b]The Chi-square test indicates a statistically significant result at the 0.05 level, [c]*The Fisher's exact test indicates a statistically significant result at the 0.05 level.* [d]*Mann-Whitney* U *statistic is significant at the 0.05 level.* [e]Effect sizes were assessed using **Phi (φ)** for 2 × 2 tables and **Cramer's V (V)** for larger tables. Following Cohen (1988), **φ values of 0.10, 0.30, and 0.50 and V values of 0.06, 0.17, and 0.29 (for df=3) denote small, medium, and large effects**, respectively. **Effect sizes for Mann–Whitney U tests were estimated using the rank-biserial correlation ($r_{(}rb_{)}$), with values of 0.10, 0.30, and 0.50 indicating small, medium, and large effects**, respectively (Cohen, 1988).

in *Fear of Failure* and *Inadequate Study Facilities*. The lower panel illustrates a gradual decline in *Active Emotional Coping* and a slight increase in *Passive Emotional Coping* with increasing depression severity, indicating that severely depressed students tend to rely less on active strategies and more on passive coping mechanisms. All medians were reported due to the non-normal distribution of the data.

The binary logistic regression analysis identified factors linked to depression, defined by a PHQ-9 score of 10 or higher. The dichotomous dependent variable indicated the
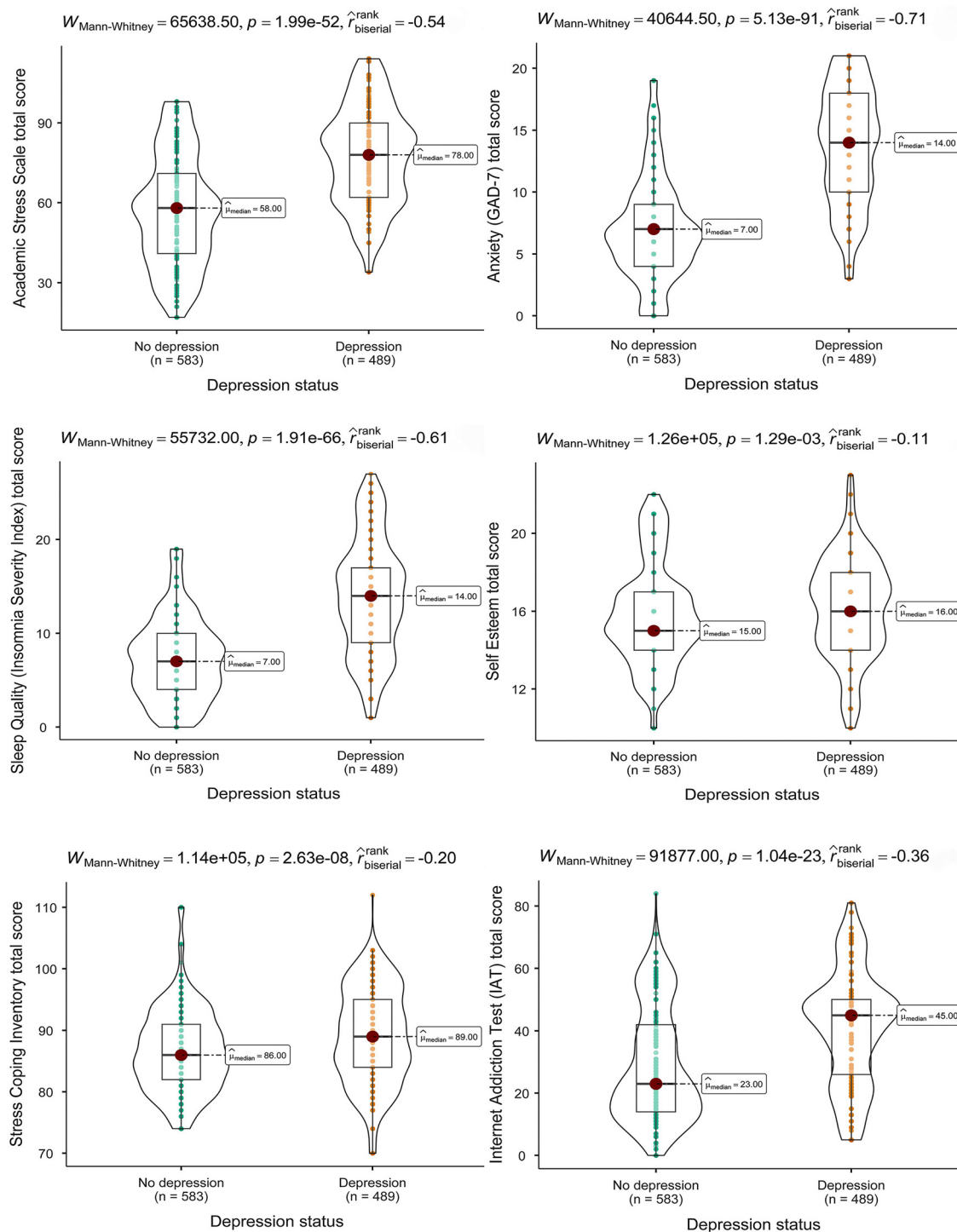
$W_\text{Mann-Whitney} = 65638.50, p = 1.99e\text{-}52, \hat{r}^\text{rank}_\text{biserial} = -0.54$

$W_\text{Mann-Whitney} = 40644.50, p = 5.13e\text{-}91, \hat{r}^\text{rank}_\text{biserial} = -0.71$

$W_\text{Mann-Whitney} = 55732.00, p = 1.91e\text{-}66, \hat{r}^\text{rank}_\text{biserial} = -0.61$

$W_\text{Mann-Whitney} = 1.26e\text{+}05, p = 1.29e\text{-}03, \hat{r}^\text{rank}_\text{biserial} = -0.11$

$W_\text{Mann-Whitney} = 1.14e\text{+}05, p = 2.63e\text{-}08, \hat{r}^\text{rank}_\text{biserial} = -0.20$

$W_\text{Mann-Whitney} = 91877.00, p = 1.04e\text{-}23, \hat{r}^\text{rank}_\text{biserial} = -0.36$

Figure 1: Comparative psychological and behavioral profiles of students with and without depression.

presence (1) or absence (0) of depression, while independent variables included demographic, socioeconomic, psychosocial, and behavioral factors. The model showed strong predictive accuracy (Deviance=505.29; AIC=549.29) with McFadden's pseudo-R^2 at 0.66, and variations of Cox and Snell's R^2 (0.60) and Nagelkerke's R^2 (0.80). The model demonstrates a high classification accuracy rate of 91 %, with a sensitivity of 88 % and a specificity of 93 %. The AUC is 0.97, indicating excellent discriminatory ability. Multicollinearity diagnostics showed VIF values from 1.15 to 2.16, and
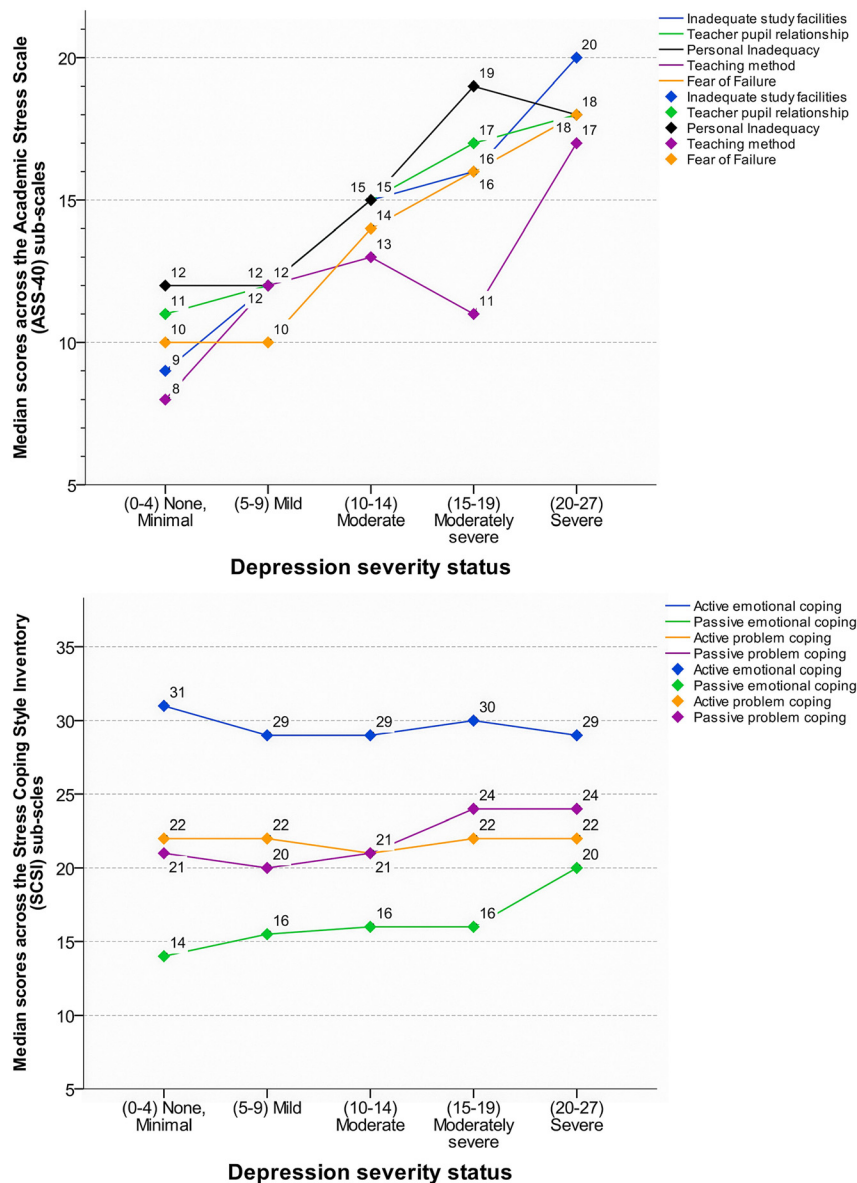
Figure 2: Differences in median academic stress and stress-coping subscales scores across depression severity levels among students.

tolerance values from 0.46 to 0.87, indicating no significant multicollinearity among predictors.

Inadequate study facilities (aOR=1.32, 95 % CI: 1.21–1.44) and personal inadequacy (aOR=1.33, 95 % CI: 1.23–1.43) significantly elevated depression risk. Passive problem-focused coping increased the likelihood of depression (aOR=1.17, 95 % CI: 1.08–1.26), whereas passive emotional coping demonstrated a reducing effect (aOR=0.91, 95 % CI: 0.85–0.98). Active emotional coping was marginally associated with depression risk (aOR=1.07, 95 % CI: 1.00–1.15). Sociodemographic factors significantly predicted depression risk. Female students demonstrated substantially reduced odds of depression compared to males (aOR=0.35, 95 % CI: 0.19–0.68). Urban residence was inversely associated with depression relative to rural settings (aOR=0.40, 95 % CI:

0.19–0.86). Analysis revealed an inverse association between higher paternal education levels and depression likelihood (aOR=0.09, 95 % CI: 0.04–0.21). In contrast, maternal educational attainment exceeding secondary level demonstrated a positive association with depression risk (aOR=4.07, 95 % CI: 1.61–10.33). Analysis indicated that increased personal income was significantly associated with a 49 % reduction in the odds of depression (aOR=0.51, 95 % CI: 0.27–0.96).

Behavioral factors were critical predictors: Insomnia severity increased depression odds by 38 % (aOR=1.38, 95 % CI: 1.29–1.48). The observed relationship between internet use and depression reversed after controlling for confounding variables. While the unadjusted model suggested moderate internet users had 2.59 times higher odds of depression than non-users (cOR=2.59), the adjusted model

Table 4: Factors influencing depression in medical students (n=1,072).

Predictor	p-Value	Crude Odds ratio (cOR)	95 % CI for (cOR)		Adjusted odds ratio (aOR)	95 % CI for (aOR)	
			Lower	Upper		Lower	Upper
Inadequate study facilities [score]	<0.001	1.21	1.17	1.24	1.32	1.21	1.44
Personal inadequacy [score]	<0.001	1.20	1.16	1.23	1.33	1.23	1.43
Passive problem coping [score]	<0.001	1.08	1.05	1.12	1.17	1.08	1.26
Passive emotional coping [score]	0.012	1.12	1.09	1.16	0.91	0.85	0.98
Active emotional coping [score]	0.049	0.97	0.94	1.00	1.07	1.00	1.14
Sex: Female – Male[a]	0.001	0.78	0.61	1.00	0.35	0.19	0.68
Insomnia [insomnia severity index ISI score]	<0.001	1.26	1.23	1.30	1.38	1.29	1.48
Personal income: Yes – No[a]	0.035	0.93	0.66	1.29	0.51	0.27	0.96
Living area: Urban – Village/rural[a]	0.019	0.66	0.47	0.93	0.40	0.19	0.86
Father's education: Educated – Not educated[a]	<0.001	1.38	1.07	1.77	0.09	0.04	0.21
Mother's education: Secondary – Below secondary[a]	0.031	0.46	0.29	0.71	2.57	1.09	6.09
Mother's education: ≥Higher secondary – Below secondary[a]	0.003	0.46	0.29	0.71	4.07	1.61	10.33
Internet addiction scale: Moderate internet use – No use[a]	<0.001	2.59	1.88	3.55	0.26	0.13	0.52
Anxiety [GAD-7 total score]	<0.001	1.37	1.32	1.42	1.78	1.61	1.97

Estimates represent the log odds of "PHQ, cat=Depression" vs. "PHQ, cat=No depression." Model fit measures: Deviance=505.29, AIC=549.29, McFadden's pseudo-R-squared=0.66, Cox and Snell's R^2=0.60, Nagelkerke's R^2=0.80, Tjur's R^2=0.70. Variance inflation factor VIF, range=[1.15 to 2.16] &Tolerance range=[0.46 to 0.87]. Case classification summary; Accuracy=0.91, Specificity=0.93, Sensitivity=0.88, Area Under Curve AUC=0.97. [a]Reference category.

showed they had 74 % lower odds (aOR=0.26, 95 % CI: 0.13–0.52). This indicates that the initial association was likely confounded by factors such as anxiety, insomnia, academic stress, and coping styles. Once these were accounted for, moderate internet use emerged as a potential protective factor, possibly by providing social connection and resources that mitigate depression risk. Lastly, after adjusting for covariates, anxiety severity demonstrated a strong, positive association with depression (aOR=1.78, 95 % CI [1.61, 1.97]), indicating a 78 % increase in the odds of depression for each one-unit increase on the anxiety scale [Table 4].

Discussion

This study reveals critical insights into academic stress and coping strategies as predictors of depression among medical students in Bangladesh, emphasizing the impact of sociodemographic, behavioral, and economic factors. The findings indicate a complex relationship between academic stressors, coping mechanisms, and mental health, suggesting interventions to alleviate depression in this vulnerable group.

Academic stress is a significant predictor of depression, confirming previous research that positions medical education as highly stressful [1]. Inadequate study facilities and feelings of personal inadequacy emerged as significant modifiable predictors of depression, underscoring the critical role of institutional resources and self-perception in

mental health outcomes. These findings align with prior research highlighting how environmental stressors (e.g., inadequate academic infrastructure) and internalized pressures (e.g., perceived incompetence) exacerbate psychological distress among medical students [35, 36]. Addressing these factors through targeted interventions, such as improving physical learning environments and implementing competency-building workshops, could mitigate the risk of depression by reducing systemic and cognitive burdens [9, 10, 37].

Coping strategies played a critical role in depression risk, with maladaptive approaches (e.g., avoidance) exacerbating symptoms; however, adaptive emotional regulation demonstrated protective effects, aligning with Lazarus and Folkman's transactional model of stress [9, 10, 37]. The observed decrease in the risk of passive emotional coping can be attributed to culturally adaptive strategies that resonate with Bangladesh's sociocultural environment. This subscale encompassed acceptance-based approaches (e.g., emotional regulation, cognitive reframing) rather than avoidance, aligning with Lazarus and Folkman's model, where emotion-focused coping is adaptive for uncontrollable stressors like systemic academic pressures [9, 10]. Cultural norms discouraging overt help-seeking (especially among males) make internal emotional regulation pragmatically protective, while females leveraged similar strategies within social networks for resilience [17–19]. This contrasts with typically maladaptive avoidant coping [10–13] but is explained by: (1) the SCSI's inclusion of constructive acceptance items (e.g., "I try to see the positive side"), and (2)

high-demand environments where rigid problem-solving may cause exhaustion, making emotion-focused strategies a sustainable alternative [11, 37, 38]. Active emotional coping had a modest effect, highlighting its context-dependent nature. Promoting adaptive coping, such as emotional regulation and problem-solving through counseling and stress management workshops, is crucial [38, 39].

Behavioral and psychosocial factors were significant predictors of depression. Insomnia increased the odds of depression by 38 %, which aligns with existing literature that highlights the impact of poor sleep on mental health issues [14]. A notable finding involved internet use. The initial, unadjusted analysis suggested moderate internet use was harmful. However, after controlling for other psychological and social variables, this relationship reversed, indicating that moderate use may actually be protective against depression; however, excessive internet use could have negative effects [14, 40]. Additionally, anxiety, as measured by the GAD score, was a strong predictor of depression, underscoring the importance of integrated mental health interventions [15, 41, 42].

Sociodemographic factors also impacted depression risk. In our study, female medical students in Bangladesh exhibited lower depression odds than male participants, contrasting with global trends that show higher rates of major depressive disorder in females [17, 18, 43, 44]. This inverse association underscores a distinct interplay of resilience factors and gendered societal expectations within the Bangladeshi context. Female medical students often originate from educated, supportive familial environments and have navigated significant barriers to enter a highly competitive and prestigious field, fostering enhanced psychological resilience. Within the academic environment, they tend to cultivate robust peer networks and employ adaptive, emotion-focused coping strategies, such as seeking social support and cognitive reframing, which are culturally validated and effective in mitigating academic stress (Lazarus & Folkman, 1984) [9, 10]. In contrast, male medical students frequently encounter heightened societal pressure to fulfil the role of primary economic providers, exacerbating stress reactivity and promoting reliance on maladaptive coping mechanisms such as avoidance, thereby elevating their susceptibility to depression [16, 18]. Furthermore, prevailing stigma surrounding mental health often discourages help-seeking behavior among males, while facilitating greater support access for females. Although broader Bangladeshi society is characterized by patriarchal norms and systemic inequities that typically elevate depression risk among women, female medical students represent a buffered subgroup. Their relative socioeconomic privilege, institutional resources, and effective coping strategies serve protective functions. Thus, the observed gender disparity does not signify an absence of structural inequality but rather highlights the moderating role of contextual privileges and adaptive resources within this specific demographic.

Urban residents had reduced depression chances compared to rural residents, likely due to better access to mental health resources in urban areas [20, 21, 45]. However, contrasting studies indicate higher depression rates in urban areas, suggesting both regions face unique mental health challenges [46, 47]. Elevated paternal education correlated with lower depressive symptoms in students, while higher maternal education corresponded with increased risk, possibly due to amplified academic pressure [26, 27, 48]. In Bangladesh's collectivist society, higher maternal education is linked to increased depression risk among medical students through several interconnected factors. Mothers with higher levels of education often take on the role of primary academic mentors, setting ambitious expectations for their children, especially in prestigious fields such as medicine, as a pathway to upward social mobility. Additionally, with female labor force participation remaining low (19.2 % in 2023), many educated mothers may experience unfulfilled professional aspirations, which can intensify the academic pressure placed on their children. The elevated social status of medical education further motivates mothers with secondary or higher education to push for this demanding career path, contributing to heightened performance anxiety. Conversely, elevated paternal education levels appear to confer socioeconomic advantages while avoiding comparable emotional or academic pressures, resulting in significantly lower depression odds.

In our study, higher personal income, particularly from part-time tutoring, was associated with a 49 % reduction in the likelihood of experiencing depression. This indicates that financial stability can alleviate stress and enhance access to mental health resources [22, 23, 49, 50]. Providing merit-based scholarships or targeted subsidies to low-income students can help address economic challenges and reduce the risk of depression among medical students in Bangladesh.

While individual coping strategies are important, the study results emphasize the need for comprehensive, multi-level interventions engaging institutions, families, and society. Medical colleges need to address modifiable stressors such as inadequate facilities and poor relationships between teachers and students. This can be achieved by enhancing infrastructure, providing faculty training, and academic counselling. The increase in depression among students from dorms and rural areas highlights the need for better mental health services, such as embedded counselors

and telepsychiatry, to reduce geographic disparities. Parental programs should focus on balanced expectations and emotional support. Societal measures include need-based scholarships and subsidized living costs to ease financial stress. Overall, effective depression reduction requires coordinated efforts across institutional, familial, and societal levels to create supportive learning environments, emotionally nurturing homes, and an economically sustainable academic environment.

This study has several key strengths. It employed validated assessment tools, including the PHQ-9, GAD-7, ISI, SCSI, and ASS, to effectively measure depression, anxiety, insomnia, coping strategies, and academic stress. The large sample size of 1,072 participants from six public medical colleges in Bangladesh enhances the diversity and representativeness of the findings. The methodological rigor is further enhanced by employing techniques such as binary logistic regression, AUC analysis, and effect size measurements. However, the study has notable limitations. The cross-sectional design prevents the establishment of causal relationships, highlighting the need for longitudinal studies to gain deeper insights. Self-reported data may introduce bias, particularly on sensitive topics such as mental health. Furthermore, the generalizability of the findings may be limited to public medical colleges, as significant confounding variables, such as peer influence and the institutional environment (both academic and administrative), could differ in private medical colleges. Additionally, the study may be influenced by information bias, as clinical students are likely to have had more exposure to the subject matter through prior psychiatry lectures compared to their nonclinical counterparts.

Conclusion and recommendations

This study examines the complex interplay of factors contributing to depression among medical students in Bangladesh, including academic stress, ineffective coping strategies, anxiety, insomnia, and internet addiction, while also highlighting the critical role of balanced internet use, financial support, and parental expectation. An integrated intervention should focus on reducing psychological stressors, promoting effective coping skills, and developing a supportive academic environment. Key recommendations involve introducing mentorship programs, implementing stress management strategies, and expanding mental health support, with a focus on high-risk groups such as male, economically disadvantaged, and rural students.

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