

Perceived Stress, Stressors, and Recommendations Suggested by Medical Students: A Convergent Mixed-Methods Study

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Research Article

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Posted Date: September 18th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10663195/v1>

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Additional Declarations: No competing interests reported.

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ABSTRACT

Introduction: Stress among medical students is a global concern that affects their well-being, learning, and future professional performance. Although Bangladeshi studies have quantified stress prevalence and stressors, evidence on students' lived experiences, coping responses, and recommendations for well-being is limited. This study aimed to assess stress and stressors among medical undergraduates; explore stress experiences, contextual stressors, coping, and recommendations; and integrate quantitative and qualitative findings for institutional stress-reduction strategies.

Methods: A convergent mixed-methods study was conducted on medical students from one private (PrMC) and one public (PbMC) college in Dhaka, Bangladesh. The quantitative survey included 201 participants using proportionate stratified random sampling. Perceived stress and stressors were assessed using the Perceived Stress Scale-10 (PSS-10) and Medical Student Stressor Questionnaire (MSSQ-40). The qualitative component comprised six focus groups with 53 students from various academic phases. Quantitative data were analyzed using descriptive statistics, non-parametric tests, and multivariable regression, and qualitative data using reflexive thematic analysis. The findings were integrated using joint display and meta-inference.

Results: The mean PSS-10 score was 22.23 ± 6.19 , with 70.6% and 24.4% of participants reporting moderate and high stress, respectively. Academic-related (mean = 2.252) and teaching- and learning-related stressors (mean = 2.024) were the highest-rated MSSQ-40 domains. Female sex and private medical college enrolment were independently associated with lower stress, whereas academic-related stressors were associated with higher stress (all $p < 0.01$). Qualitative analysis showed stress stemmed from interconnected academic, institutional, and social contexts, including workload, assessment pressure, unsupportive institutional practices, limited recreational and social infrastructure, and inadequate mental health services. Students described informal peer support as a lifeline. Although students employed both problem- and emotion-focused coping strategies, many perceived these responses as insufficient because organizational constraints limited their effectiveness. Students often see stress as inevitable in academia and endure it. Participants suggested refining curriculum, supportive faculty interactions, a better learning environment, and trustworthy mental health resources.

Conclusion: Medical students in Bangladesh experience moderate-to-high stress driven by academic, institutional and social contexts. Improving medical student well-being requires system-level reforms that address academic structures, institutional support, and learning environments rather than relying solely on individual resilience-focused approaches.

Keywords: Medical students, Perceived stress, Academic stressors, Mixed-methods research, Medical education, Perceived Stress Scale, Medical Student Stressor Questionnaire

Background:

Medical education is widely recognized as one of the most academically demanding forms of professional training, requiring students to acquire extensive scientific knowledge, clinical competence, and professional behavior before entering independent medical practice [1]. Achieving these competencies requires intensive lectures, demonstrations, supervised clinical practice, mentoring, practical training, and continuous assessment [2]. Medical training involves an intensive academic workload, emotional demands, prolonged clinical exposure, and encounters with illness and death, placing students under substantial psychological pressure [3]. Moreover, medical students are subjected to high expectations from their families, peers and society [4]. Stress may have several consequences, such as decreased attention, reduced concentration, depression, burnout, poor sleep quality, anxiety, suicidal tendencies, and drug abuse [5-7]. Persistent stress may also contribute to cardiovascular, neurological, and renal disorders [4]. Studies have consistently reported a higher burden of psychological distress among medical students in several Asian countries, including Bangladesh, than in many Western countries [8].

In Bangladesh, medical students experience higher stress (90% under moderate to high stress) than the general population (47-59.7%) [8-10]. Previous studies have identified academic stress as the predominant stressor among undergraduate medical students, followed by psychological and social stressors [11, 12]. Individuals respond to stress through various coping strategies that regulate their behavioral and emotional responses to perceived stress [13]. This process is conceptualized by Lazarus and Folkman's Transactional Theory of Stress and Coping, which proposes that individuals first appraise whether an event is threatening and then evaluate the resources available to cope with it [14]. Previous cross-sectional studies in Bangladesh have reported that medical students adopt a range of coping strategies, with approximately 82% perceiving these strategies to be effective in reducing stress [11]. Despite widespread use of coping strategies and high perceived coping effectiveness, the persistence of moderate-to-high stress among Bangladeshi medical students suggests that coping responses alone may be insufficient to offset prevailing academic and contextual stressors.[15].

Bangladesh has more than 110 public and private medical colleges that deliver undergraduate medical education [16]. Although both sectors follow a common national curriculum, they differ in terms of institutional

culture, learning environment, available resources, and student support systems. Studies have shown that public medical college (PbMC) students experience higher stress levels than private medical college (PrMC) students [11]. These institutional differences may contribute to the observed variations in stress levels between institutions.

Studies have described stress distribution, stressors, and predictors. However, little is known about how medical students experience stress, navigate academic and contextual challenges, and which interventions they perceive as acceptable and beneficial. Understanding these experiences is essential for designing contextually appropriate interventions to improve students' well-being. Quantitative studies can estimate stress magnitude and determinants but cannot adequately explain how students experience and respond to stress or which institutional changes they perceive as meaningful. Therefore, integrating quantitative and qualitative evidence can provide an understanding of interventions. Accordingly, this convergent mixed-methods study aimed to (1) assess perceived stress and stressors among undergraduate medical students in Bangladeshi medical colleges; (2) explore students' experiences of stress, contextual stressors, coping responses, consequences, and recommendations for improving well-being; and (3) integrate quantitative and qualitative findings to generate meta-inferences informing evidence-based institutional strategies to reduce student stress.

Methods:

Theoretical framework:

This study was based on the transactional theory of stress and coping proposed by Lazarus and Folkman. They suggested that stress arises from a two-way interaction between an individual's response and their environment [14]. The way an individual evaluates stressors and perceives the resources available to handle them affects health and well-being, and is linked to the interaction between stress and coping. Initially, a stressor might be appraised as a threat or a normal event. In secondary appraisal, even if the stressor is considered a threat, the individual might perceive it as manageable with resources at hand; otherwise, stress is activated, prompting coping strategies to manage it. The result of this response can be positive or negative, requiring reassessment of whether the situation is stressful (Fig. 1).

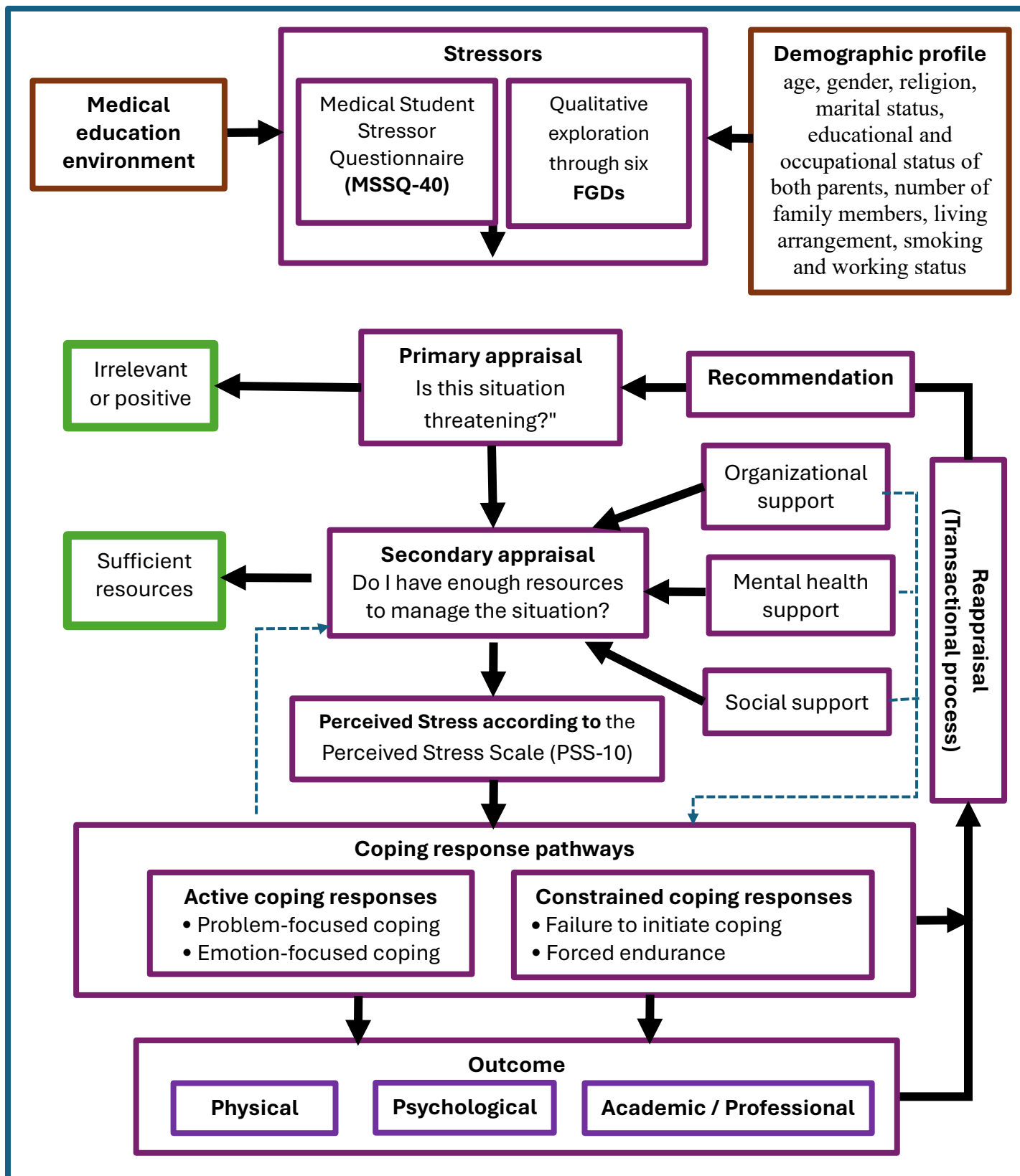


Fig. 1 Conceptual framework adapted from Lazarus and Folkman's (1984) transactional model of stress and coping

Description: Conceptual framework illustrating the relationships among perceived stressors, cognitive appraisal, coping resources, coping responses, stress consequences, and recommendations. The framework is

adapted from Lazarus and Folkman's Transactional Theory of Stress and Coping and refined using the integrated quantitative and qualitative findings of this study.

In our study, we employed the Medical Student Stressor Questionnaire (MSSQ-40), created by Yusof et al., to identify the stressor domains affecting stress levels. This questionnaire is a valid and reliable tool for medical students, with a Cronbach's alpha of 0.95 [17, 18].

Finally, we used the Perceived Stress Scale (PSS-10) to assess students' stress levels. This tool is recognized as valid and reliable for the Bangladeshi population, with a Cronbach's alpha of 0.750 and test-retest reliability over two weeks ($r = .745$, $p < .01$) [19].

Design and settings:

In this convergent mixed-methods research, data were collected from a public medical college (PbMC) and a private medical college (PrMC) in Dhaka, Bangladesh, to ensure diversity. Both institutions are governed by the University of Dhaka and follow a standardized curriculum of the Government of Bangladesh. Nevertheless, private medical colleges mainly serve students from affluent urban backgrounds, with tuition fees higher than those charged by government colleges. The quantitative component used a survey to assess the prevalence of perceived stress, influencing factors, and domain-specific stressor profiles. The qualitative component used Focus Group Discussions (FGDs) to explore students' stress experiences, coping responses, and suggestions for institutional interventions.

Study population, sampling, and sample:

The quantitative strand included medical students in the 2nd to 4th years, spanning all three phases of the curriculum. Participants were eligible only if they were formally registered and regularly attended classes during the data collection period. Students with serious medical conditions, mental illnesses, attending professional examinations, or on extended leave of absence were excluded. A new batch entered as 1st year during the data collection period; hence, they were excluded. Similarly, 5th-year students were excluded because of ongoing professional examinations.

Respondents were stratified by academic year and gender and selected by proportionate random sampling using class registers as a sampling frame. Participants in qualitative component were purposively recruited from three academic phases. Eligible students were invited through institutional coordination and class representatives.

Sample size:

The sample size was estimated using $n = z^2\sigma^2/d^2$, with $z = 1.96$ (95% confidence), $\sigma = 5.78$ (PSS-10 standard deviation in a Bangladeshi population [19], and $d = \pm 1.5$ score units (as the PSS-10 is a 0-40 scale, d represents 3.75% of the range), yielding a minimum of 58 students. After a 10% non-response correction, 65 students were required for each institution. The study included two purposively selected institutions, requiring 130 (65+65) participants. The target was raised to 100 per institution (~33 per academic year) to enable proportionate stratified allocation across three years and subgroup analyses by year, sex, and institutional type, with a total of 200. The sample size was 201, exceeding the minimum requirement. Finally, 100 students from PrMC and 101 from PbMC participated in the survey. Among them, third-year students had the highest proportion (39.3%), while 2nd and 4th year students were equal (both 30.3%).

For the qualitative component, six FGDs were conducted, three for each institution. Each FGD covered one academic phase to facilitate discussion within the participants pre-existing familiarity. Seven to ten participants attended each session (planned: 10–12), yielding 53 respondents (PrMC, $n=30$; PbMC, $n=23$) across six FGDs. In PrMC, 6 respondents, and in PbMC, 13 respondents, refused to participate due to academic overload and examinations. The sample size was informed by Hennink and Kaiser, who demonstrated that thematic saturation can be achieved within approximately 12–13 participants in homogeneous groups [20]. Data collection continued across institutional and academic strata until no themes emerged in the sixth FGD, indicating that thematic saturation had been achieved.

Data collection:

In the quantitative phase, data were collected using a pretested (with 20 students) semi-structured, anonymous, self-administered questionnaire through face-to-face interviews lasting approximately 25 minutes.

FGDs were conducted by four academic and public health professionals (all MBBS and MPH). Before data collection, the first author (INN) provided training in qualitative interviewing, focus group facilitation, instruments, coding, and reflexive thematic analysis. Each FGD had one moderator and one note-taker, with roles rotated between two researchers (ZR and SA, both female). Neither moderators nor notetakers had any teaching, supervisory, or assessment relationship with participants. Before each discussion, moderators introduced themselves, explained the study objectives and their professional backgrounds, and informed participants that the study aimed to understand medical students' experiences of stress and well-being. The moderator used the semi-structured interview guide, encouraged participation, and neutral probing; the note-taker documented field notes, non-verbal interactions, group dynamics, observations, and monitored recording. Each session was supervised by either INN or IR (both male) to ensure protocol adherence, consistency, and post-session debriefings. Only participants and research team members were present during the FGD. Reflexivity was maintained through team discussions during data collection, coding, theme development, and interpretation of findings.

Transcripts were not returned for comment or correction. Instead, after each FGD, the moderator summarised key issues and sought participants' confirmation and clarification to ensure accurate understanding before concluding. A unique code was assigned to each participant. Each FGD took 45 minutes to one hour. We obtained permission from the participants to audio-record their conversations during the FGD. The research team collected data for both components from March 31st to May 10, 2026.

Instrument:

In the survey arm, a semi-structured questionnaire was developed after reviewing the literature. Our questionnaire consisted of three sections: 1. Section A: Socio-demographic characteristics of the participants, 2. Section B: MSSQ-40, and 3. Section C: PSS-10. The sociodemographic section acquired data on age, gender, religion, marital status, educational and occupational status of both parents, number of family members, living arrangement, smoking, and working status. In Section B, the MSSQ is a 40-item instrument that identifies the sources of stress and measures the intensity of stress considering six domains: Drive and Desire-Related Stressors (DRS), Social-Related Stressors, Intrapersonal/Interpersonal-Related Stressors, Teaching and Learning-Related

Stressors (TLRS), Academic-Related Stressors (ARS), and Group Activities-Related Stressors (GARS). Each item was rated on a 5-point Likert scale according to the degree of stress it caused the respondent, where 0 = no stress, 1 = mild stress, 2 = moderate stress, 3 = high stress, and 4 = severe stress. The analysis showed the ranges of stress levels, with the mean score of each domain calculated as follows: 0–1.0, mild stress; 1.01–2.00, moderate stress; 2.01–3.00, high stress; and 3.01–4.00, severe stress. In Section C, the PSS-10 comprises ten items. Respondents were required to rate each item on a 5-point Likert scale from 0 (never) to 4 (very often), indicating the frequency of their feelings or thoughts regarding the items during the last month. A higher composite score indicates more stress.

For the qualitative arm, a semi-structured FGD guide developed by the research team facilitated discussions. Informed by the study objectives and Lazarus and Folkman's Transactional Theory of Stress and Coping, it included open-ended questions and probes on stress experiences, stressors, coping responses, consequences, and recommendations to improve well-being. The guide was tested with students outside the study and revised for clarity, sequencing, and wording before FGDs.

Statistical analysis:

Survey data were analyzed using SPSS version 25. Descriptive statistics summarised characteristics, perceived stress, and MSSQ-40 domain scores. Normality of continuous variables was assessed by inspection of histograms, Q–Q plots, and Shapiro-Wilk test. Continuous variables were not normally distributed (Shapiro-Wilk $p < 0.05$) for both PSS-10 and MSSQ-40 scores. Mann–Whitney U and Kruskal–Wallis tests with Bonferroni-corrected post-hoc pairwise comparisons were used to compare two and three or more independent groups, respectively. We used Spearman's correlation to analyze associations between continuous variables. To identify independent predictors of PSS-10, we conducted multivariable ordinary least squares (OLS) regression with robust standard errors, with PSS-10 score as the dependent variable and sex, age, academic year, institution, and six MSSQ-40 domain scores entered simultaneously. Variance inflation factor (VIF) for multicollinearity, Cook's

distance for influential observations, and residual normality checks were performed for model diagnostics. A two-tailed p-value of less than 0.05 was considered statistically significant.

FGD transcripts were finalized using voice recordings and field notes. They were verified by consensus among the supervisor, moderators, and note takers. Data were analyzed using reflexive thematic analysis guided by Braun and Clarke's six-step approach: (1) familiarization with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report. Codes, subthemes, and themes were derived using a descriptive coding approach, with attention to the in vivo expressions used by the respondents. Alongside the main themes, the findings describe variance in participants' experiences, including less frequently reported and opposing viewpoints when pertinent. The moderator and note-taker individually coded each FGD transcript. Codes with similar meanings were iteratively grouped into categories (subthemes), which were subsequently refined into overarching themes through team discussion and constant comparison across transcripts. The framework comprised 108 codes (C), 31 subthemes (ST), and 9 themes (T) across four sections: 1. coping resources (C-26, ST-10, T-3), 2. stressors (C-34, ST-12, T-3), 3. coping responses (C-18, ST-4, T-2), and 4. stress-reduction recommendations (C-30, ST-5, T-1).

Integration process:

The relationship, comparison, integration, and meta-inference of qualitative and quantitative data are illustrated in a side-by-side joint display. Quantitative findings, with illustrative qualitative themes/quotes for each outcome area, were tabulated. Equal priority was afforded to QUAL and QUAN strands. Integration was accomplished through convergent triangulation, identifying (1) confirmed, (2) discordant, (3) expanded, and (4) complementary meta-inferences. Confirmed meta-inferences indicated agreement between strands, whereas discordant meta-inferences reflected conflict. When strands diverge but contribute to richer understanding, resulting meta-inferences are classified as expanded or complementary, depending on whether they introduce new dimensions or reinforce each other's meanings. The meta-inference development followed a logical process in which qualitative (by IR) and quantitative (by NI) inferences were integrated through a consensus among the research team (with INN).

Ethical considerations:

Ethical approval was obtained from the Bangladesh Medical Research Council (BMRC) Ethical Review Committee (Ref: BMRC/NREC/2025-2026/646(01-168), dated: 15/04/2026), and permission was obtained from the authorities before data collection. Written informed consent was obtained from all the participants. Confidentiality and anonymity were maintained, with no personal identifiers present in the dataset, reports, or publications. The collected data, including audio recordings, transcripts, and questionnaires, were securely stored and accessible only to the research team.

Result:

Sociodemographic characteristics of respondents:

Table 1 displays the sociodemographic profiles of the survey participants, including the distribution of all respondents and a comparison of PrMC and PbMC. A total of 201 undergraduate medical students completed the questionnaire. All consented participants were included in the final quantitative analyses, with no missing data requiring exclusion. The mean age of the participants was 21.78 years (SD = 1.20), ranging from 19 to 25 years.

The majority of participants were female (62.7%), and there was nearly equal academic-year representation: 2nd year, 30.3%; 3rd year, 39.3%; and 4th year, 30.3%. Most participants were Muslim (84.6%), unmarried (93.5%), non-smokers (92.0%), and resided in an urban area (88.1%) with diverse living arrangements. Parental education shows that 83.6% of fathers and 66.7% of mothers hold either a graduate or post-graduate qualification. The mean family income was BDT 133,060 per month (SD=154, 783), a with median of BDT 100,000.

The sample characteristics of the FGD participants and an overview of the FGD are shown in Tables 1 and 2 (Additional file 1, Table 2), respectively. FGDs 01–03 included respondents from PrMC (Phases 1–3, respectively), while FGDs 04–06 were conducted among PbMC students. All FGDs except FGD01 (only male) had both male and female participants. FGD participants were predominantly male (60.4%), Muslim (86.8%), and unmarried (94.3%) medical students from urban backgrounds (96.2%), aged between 19 and 24 years old. They were distributed across the 2nd, 3rd, and 4th years of MBBS in roughly equal proportions. Most came from highly educated families; over 62% had postgraduate fathers and 41.5% had post-graduate mothers. Government service and business were the most common paternal occupations, whereas most mothers were homemakers (66.0%).

269 **Table 1: Demographic characteristics of respondents (n=201)**

Characteristic	Category / Statistic	Quantitative Data			Qualitative Data (n =53)
		Overall (n=201) n (%) or Mean ± SD	PrMC (n=100)	PbMC (n=101)	
Age (years)	Mean ± SD	21.78 ± 1.20 (Range:19–25)	22.06 ± 1.16 (Range:19-24)	21.50 ± 1.18 (Range:19-25)	21.51 ± 1.34, 19 – 24
Gender	Male	75 (37.3%)	37 (37%)	38 (37.6%)	32 (60.4%)
	Female	126 (62.7%)	63 (63%)	63 (62.4%)	21 (39.6%)
Academic Year	2nd Year	61 (30.3%)	35 (35%)	26 (25.7%)	18 (34.0%)
	3rd Year	79 (39.3%)	33 (33%)	45 (45.5%)	18 (34.0%)
	4th Year	61 (30.3%)	32 (32%)	29 (28.7%)	17 (32.1%)
Religion	Islam	170 (84.6%)	85 (85%)	85 (84.2%)	46 (86.8%)
	Hinduism	31 (15.4%)	15 (15%)	16 (15.8%)	7 (13.2%)
Marital Status	Unmarried	188 (93.5%)	91 (91%)	97 (96%)	50 (94.3%)
	Married	13 (6.5%)	9 (9%)	4 (4%)	3 (5.7%)
Father's Education	Graduate	77 (38.3%)	40 (40%)	37 (36.6%)	13 (24.5%)
	Post-graduate	91 (45.3%)	49 (49%)	42 (41.6%)	33 (62.3%)
	Up to Higher Secondary	32 (15.9%)	11 (11%)	22 (21.7%)	7(13.2%)
Mother's Education	Graduate	92 (45.8%)	51 (51%)	41 (40.6%)	18 (34.0%)
	Post-graduate	42 (20.9%)	20 (20%)	22 (21.8%)	22 (41.5%)
	Up to Higher Secondary	67 (33.3%)	29 (29%)	38 (37.6%)	13(24.5%)
Place of Residence	Urban	177 (88.1%)	99 (99%)	78 (77.2%)	51 (96.2%)
	Rural	24 (11.9%)	1 (1%)	23 (22.8%)	2 (3.8%)
Living Arrangement	With family	92 (44.8%)	51 (51%)	41 (40.6%)	37 (69.8%)
	Hostel	76 (37.8%)	27 (27%)	49 (48.5%)	11 (20.8%)
	Other living arrangements	33 (16.4%)	22 (22%)	11 (10.9%)	5 (9.4%)
Working besides study	No	184 (91.5%)	87 (87%)	97 (96%)	48 (90.6%)
	Yes	17 (8.5%)	13 (13%)	4 (4%)	5 (9.4%)
Smoking Status	Non-smoker	185 (92.0%)	84 (84%)	101 (100%)	-
	Smoker	12 (6.0%)	12 (12%)	-	-
	Ex-smoker	4 (2.0%)	4 (4%)	-	-
Family Income (BDT/month)	Median	100,000	120000	100000	-

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271 **Burden of perceived stress and coping resources**

272 The mean PSS-10 total score was 22.23 (SD = 6.19), indicating moderate-to-high perceived stress across

273 the samples. The Perceived Helplessness subscale contributed proportionally more to the total score (M = 13.19,

274 SD = 4.81) than Lack of Self-Efficacy subscale (M = 9.04, SD = 2.64) (Table 3). As illustrated in Fig. 2, most

275 participants (70.6%, n = 142) fell within the moderate stress category, followed by high stress (24.4%, n = 49).

Table 3. Descriptive Statistics for PSS-10 Total Score and Subscales (N = 201)

Scale	Items (n)	Mean $\pm$ SD	Mean Item Score	Median	IQR	Range
PSS-10 Total Score	10	22.23 $\pm$ 6.19	2.22	21.0	18.0–26.0	8–39
Perceived Helplessness	6	13.19 $\pm$ 4.81	2.20	13.0	10.0–16.0	0–24
Lack of Self-Efficacy	4	9.04 $\pm$ 2.64	2.26	9.0	7.0–11.0	3–16

IQR = Interquartile range. Items 4, 5, 7, 8 were reverse scored.

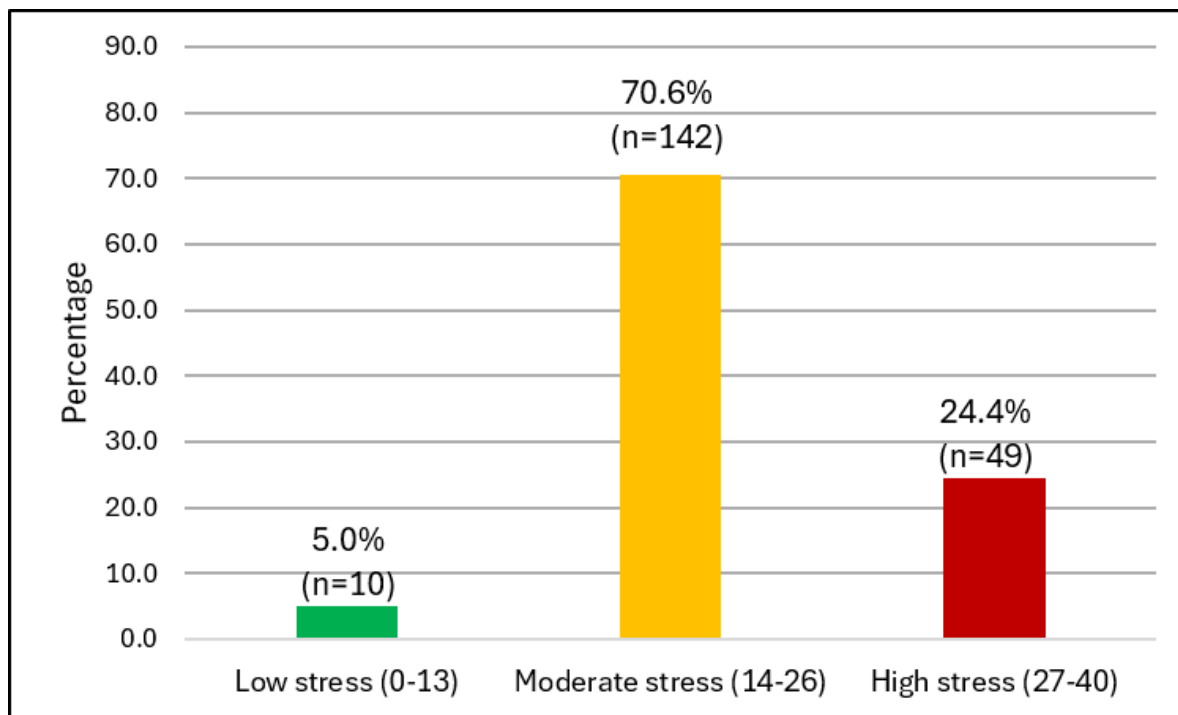


Fig. 2 Distribution of the respondents according to perceived stress

Students in all six focus groups described stress as something the profession demands of you — not a problem to solve, but a condition to endure. When asked what would help them mitigate stress (the resources), three things came up consistently: organizational support, mental health services, and social support (Additional file 1, Table 4). The only reliably available support was seniors, along with friends, who were considered a lifeline. Family was also identified as a crucial source of support.

In FGDs, students perceived the inadequacy of organizational support. Hostels were overcrowded or insufficient. Common rooms and recreational spaces either did not exist or were non-functional. There was no structured co-curricular life, which meant that informal peer connections had to happen despite the environment, not because of it.

Although mental health services were expected to guide students in overcoming these challenges, the service existed in name only. Students did not use them. The reasons were specific: they did not trust that what they disclosed would remain private, and they did not believe that the people running those services had real authority or accountability. Several participants said they would rather manage on their own than risk getting back to the faculty.

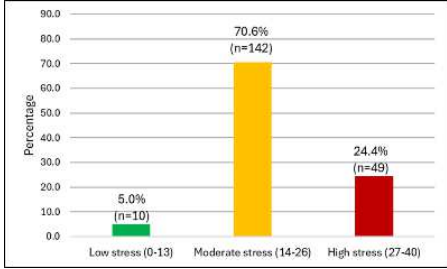
“Structural reform is needed -- band-aid solutions will not work. Mental counselling might help now, but the system must change.” [R4, M, FGD04, PbMC]

The sharpest observation across the groups was that students were not asking for counseling. They were asking for the institution to change — timetables, infrastructure, and workload distribution. They saw mental health services as a patch over a structural problem, and were skeptical that the patch was even applied in good faith.

Integrated findings:

Table 5 presents a joint display of the integrated findings regarding the burden of perceived stress and coping resources. The integration shows a complementary relationship indicating the widespread burden of perceived stress, which was contextualized by the students’ perceptions of inadequate organizational and mental health support, while informal peer support emerged as the principal coping resource.

Table 5: Joint Display Table showing distribution of perceived stress and coping resources

Latent construct	Quantitative Evidence & Inference	Qualitative Evidence & Inference	Type of Integration with rationale & Meta-inference
Perceived multilevel coping resource environment	Evidence PSS-10 mean score was 22.23 ($\pm$ SD 6.19); Of those surveyed, 70.6% are experiencing moderate levels of stress, 24.4% are under high stress, and 5.0% report low stress.  Fig. a Distribution of the respondents according to perceived stress. Inference: Moderate-to-high perceived stress was the predominant psychological state among the participating medical students.	Evidence Perceived inadequacy of organizational support: <i>“No co-curricular activities — cannot do anything outside studies. Very frustrating.”</i> [R3, F, FGD04, PbMC] Perceived inadequacy of mental health support services <i>“Bad personal experience: a psychologist broke confidentiality -- told batchmates private matters. I felt deeply betrayed.”</i> [R7, F, FGD06, PbMC] Perceived reliance on informal peer support: <i>“Senior brother/sister support — biggest mental relief. Shared pressure, motivation, advice on pending items, teaching, marking key content.”</i> [R9, M, FGD03, PrMC] Inference: Students perceived organizational and mental health support as insufficient, while informal peer support emerged as a key coping resource for managing stress.	Complementarity: The quantitative findings quantified the widespread burden of perceived stress, whereas the qualitative findings explained students' perceptions of the formal and informal coping resources available to manage them Meta-inference: The integrated findings suggest that widespread perceived stress is accompanied by perceived inadequacy of organizational and mental health coping resources, with students relying predominantly on informal social support as their principal coping resource.

Variation in perceived stress across demographic and institutional groups (bivariate analysis).

Table 6 shows the variation in PSS-10 scores across demographic groups. No statistical differences were

observed according to sex, academic year, smoking status, or living arrangement. However, students from PbMC

(n=101) reported significantly higher scores for overall perceived stress ($U = 2769.50, p < .001$), helplessness (U

$= 2912.50, p < .001$), and lack of self-efficacy ($U = 3531.50, p < .001$) than students from the PrMC. Effect sizes

were medium for total stress and helplessness and small-to-medium for self-efficacy (Fig. 3).

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Table 6. PSS-10 Total Score by Sociodemographic Variables (N = 201)

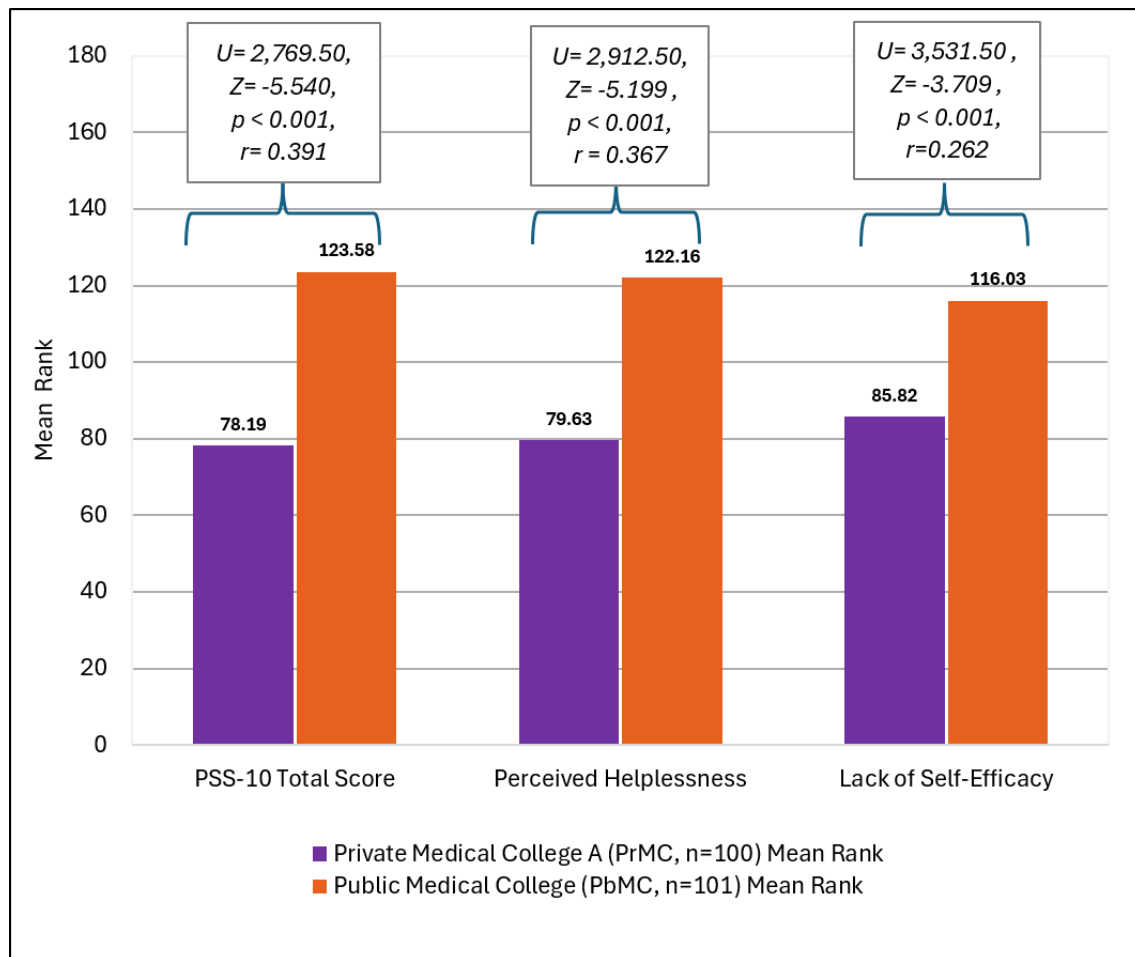
Variable	Mean	SD	Median	Test Statistic	p-value
Institution					
PrMC	19.79	4.68	19.0	U = 2769.5, z = -5.53	<0.001***
PbMC	24.65	6.57	23.0		
Sex					
Male	23.20	6.68	21.0	U = 4260, z = -1.17	0.243
Female	21.66	5.83	21.0		
Academic Year					
2nd Year	21.07	6.15	20.0	H (2) = 3.96	0.138
3rd Year	22.87	7.05	21.0		
4th Year	22.57	4.83	22.0		
Smoking Status					
Smoker	21.25	3.28	21.5	H (2) = 0.10	0.950
Non-smoker	22.32	6.36	21.0		
Ex-smoker	21.00	5.16	21.0		
Living Arrangement (Hostel vs Other)					
Hostel	21.95	6.61	21.0	U = 4438, z = -0.78	0.436
Other	22.41	5.95	22.0		

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Footnote: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Mann-Whitney U test for two groups; Kruskal-Wallis H test

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for three or more groups. (Continuous variables were non-normally distributed)



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Fig. 3 Institutional differences in perceived stress

Qualitative findings revealed notable institutional differences in the perceived support. Students from PbMC frequently mentioned inadequate organizational and mental health support issues. Although they identified informal peer support as an important coping resource, opportunities for social interaction were limited by the unavailability of social interaction-related infrastructure, such as medicine, cultural, and research clubs. In addition, limited hostel accommodation in PbMC required them to commute daily from home, reducing opportunities for peer interactions and socialization.

“PbMC has zero co-curricular activities -- no clubs at all. Medicine, cultural, research clubs needed.”

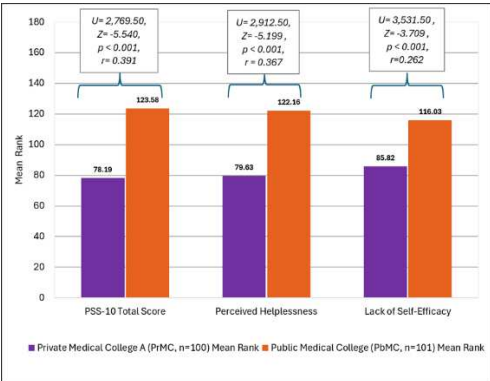
[R1, F, FGD04, PbMC]

Integrated findings:

The joint display integrates quantitative and qualitative findings related to variations in perceived stress across demographic and institutional groups (Table 7). The integration demonstrated both confirmation and complementarity effects. The quantitative findings show significantly higher stress in PbMC students, while the qualitative findings complement the result by indicating their perceived greater deficiencies in organizational and mental health support and fewer opportunities for peer interaction.

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Table 7: Joint Display Table showing variation in perceived stress across demographic and institutional groups (bivariate).

Latent construct	Quantitative Evidence & Inference	Qualitative Evidence & Inference	Type of Integration with rationale & Meta-inference
Perceived institutional disparity	Evidence 1: Demographic comparison No significant PSS difference by academic year ($H=3.97$, $p=0.137$), gender ($U = 4260$, $p=0.243$), marital status, religion, or working status. All $p>0.05$. Evidence 2: Institutional comparison Mean rank of PSS-10 along with perceived helplessness and self-efficacy scores were higher among PbMC students. (Mean Rank = 123.58 for PSS-10) than PrMC (Mean Rank = 78.19, for PSS 10).  Fig. b Institutional difference in perceived stress Inference: Medical students experienced predominantly moderate-to-high perceived stress across demographic groups, with significantly higher perceived stress among students from the public medical college.	Evidence: Perceived inadequacy of organizational support: <i>“Other colleges have an indoor zone, sports field, common room. Food more expensive than other colleges — feels guilty about admission.”</i> [R4, M, FGD04, PbMC] Perceived inadequacy of mental health support services: <i>“Bad personal experience: a psychologist broke confidentiality -- told batchmates private matters. I felt deeply betrayed.”</i> [R7, F, FGD06, PbMC] Perceived reliance on informal peer support: <i>“Not all negative. Group study and peer support are genuine positives. Classmates are the lifeline.”</i> [R8, F, FGD04, PbMC] Synthesis of evidence: Stress was discussed across all six FGDs, with participants consistently describing medical life as psychologically demanding and emotionally exhausting. Inference: Stress emerged as a shared psychological experience across FGDs; however, students from public medical college more frequently described organizational and mental health support as inadequate. Participants consistently reported their predominant reliance on informal peer support.	Complementarity and Confirmatory: The quantitative findings found absence of statistically significant difference in demographic characteristics of the students except their institution, and the qualitative evidence complemented that evidence when PbMC students identified institution-specific deficits while indicating their experience of stress across all FGDs Meta-inference: Moderate-to-high perceived stress was common across demographic groups. At the same time, informal peer support emerged as the most consistently perceived reliable coping resource; institutional disparity of organizational and mental health support may have contributed to the higher stress score among PbMC students.

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Perceived stressors of medical students:

MSSQ-40 Domain Scores:

As shown in Table 8, the six MSSQ-40 domain median scores ranged from 1.667 to 2.231. Two domains, ARS (M=2.252) and TLRS (M=2.024), exceeded the high-stress threshold (>2.00). The remaining four domains, GARS (M=1.968), IRS (M=1.924), SRS (M=1.834), and DRS (M=1.653), fell within the moderate range.

Table 8: MSSQ-40 Domain Mean Scores Ranked by Severity (N=201).

Domain	Mean $\pm$ SD	Median	IQR	Overall Severity	Mild/Mod/High/Sev (n)
Academic-Related Stressors (ARS)	2.252 $\pm$ 0.637	2.231	1.846–2.692	High	8/66/103/24
Teaching & Learning-Related Stressors (TLRS)	2.024 $\pm$ 0.671	2.000	1.571–2.429	High	16/99/69/17
Group Activities-Related Stressors (GARS)	1.968 $\pm$ 0.695	2.000	1.500–2.500	Moderate	25/96/71/9
Interpersonal-Related Stressors (IRS)	1.924 $\pm$ 0.778	2.000	1.429–2.429	Moderate	33/74/81/13
Social-Related Stressors (SRS)	1.834 $\pm$ 0.594	1.833	1.500–2.167	Moderate	17/118/59/7
Drive & Desire-Related Stressors (DRS)	1.653 $\pm$ 0.888	1.667	1.000–2.333	Moderate	61/87/39/14

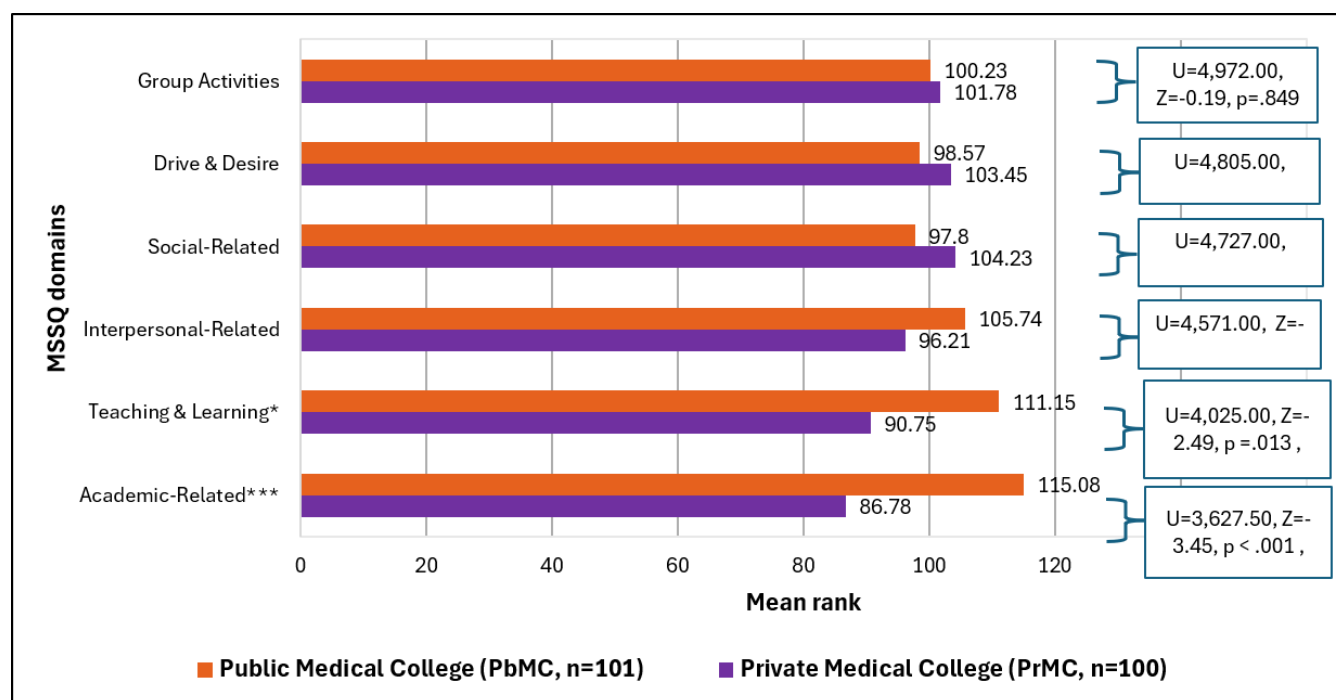
Severity classification: Mild = 0.00–1.00; Moderate = 1.01–2.00; High = 2.01–3.00; Severe = 3.01–4.00. Domains listed in rank order.

Item-level stressors:

Table 9 (Additional file 1, Table 9) presents the 10 highest-rated and 5 lowest-rated individual stressor items on the MSSQ-40 scale. All high-rated items exceeded the high-stress threshold (mean > 2.00), whereas the lowest-rated items were within the moderate stress range.

A series of Mann-Whitney U tests compared all six MSSQ-40 domain scores between PrMC and PbMC students. PbMC students reported significantly higher ARS ($U=3,627.50$, $z=-3.45$, $p<.001$, $r=0.24$) and TLRS ($U=4,025.00$, $z=-2.49$, $p=.013$, $r=0.18$) than their private institution counterparts. Effect sizes were small to medium across all significant domains. No statistically significant differences were observed for the IRS ($U=$

354 4,571.00, $p = .244$), SRS ($U=4,727.00$, $p=.431$), DRS ($U=4,805.00$, $p=.550$), or GARS ($U=4,972.00$, $p=.849$)
 355 mean rank (Fig. 4).



356
 357 **Fig. 4** Comparison of MSSQ-40 domain scores between private and public medical students

358 **Medical students' perceived stressors:**

359 According to the FGDs, stressors were explained under three themes and 12 subthemes (Additional file
 360 1, Table 10). Among these themes, Academic and Curricular-related Stressors were mentioned across all six FGDs
 361 under seven subthemes and 18 codes. Students' voices reflected those academic and curricular stressors arose
 362 from features of the medical education system rather than from isolated academic events. Respondents also
 363 mentioned institutional power and culture-related stressors under two subthemes with five codes, while social and
 364 environmental stressors were described under three subthemes and 11 codes.

365 Content mapping showed overlap between the MSSQ-40 and participants' lived experiences.
 366 Nevertheless, seven qualitatively identified stressor codes were not represented in the MSSQ-40 (expansion),
 367 while nine MSSQ-40 items were not reflected in participants' narratives. Notably, several unmatched MSSQ-40
 368 items were among our quantitative survey's lowest-rated stressors (Additional file 1, Table 9). Mapping between
 369 MSSQ-40 items and qualitative codes is shown in Table 11 (Additional file 1, Table 11).

The frequently reported subtheme was the mismatch between course content volume and time available to interact with it (Additional file 1, Table 10). Across both medical colleges and phases, students mentioned continuous assessment and a lack of recovery time for meaningful engagement in the learning process. In addition, failed items triggered cascading pending item accumulation and were described as self-reinforcing stress across the FGDs.

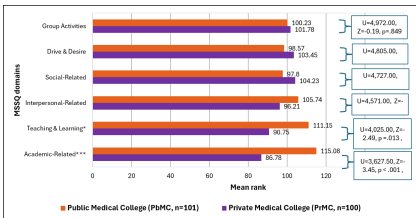
Participants described the assessment system as a stressor. Item-based oral examinations require verbatim reproduction of teacher-specified content from preferred sources rather than conceptual understanding. The assessment system, with poor teacher-student relationships, contributed to stress beyond the preparation burden imposed. Hierarchical intimidation of junior batches by senior students, suppression of reform, and normalization of suffering by institutional authority and teachers were also mentioned as stressors.

Students living away from family described emotional and practical challenges, whereas those living with family often experienced pressure from parental expectations and financial sacrifices. Participants described a competitive environment where peer comparison and fear of academic failure contributed to social isolation and stress.

Integrated findings:

Table 12 presents the integrated findings of the multilevel interacting stressor systems. The integration demonstrated both confirmation and complementarity effects. While the survey identified ARS and TLRS as the predominant stressor domains, the qualitative findings showed that these stressors were experienced within broader institutional and social contexts, providing a more comprehensive understanding of students' stress experiences.

Table 12: Joint Display Table showing Multilevel stressors (MSSQ + qualitative stressors).

Latent construct	Quantitative Evidence & Inference	Qualitative Evidence & Inference	Type of Integration with rationale & Meta-inference
Multilevel interacting stressor systems	Evidence 1: Academic-Related Stressors (ARS; mean = 2.252) ranked highest, classified as High stress, followed by Teaching & Learning (TLRS; 2.024). All other domains fell in the Moderate range. Drive & Desire Stressors (DRS; 1.653) were lowest. Evidence 2: PbMC students reported significantly higher ARS ($p < .001$) and TLRS ($p = .013$), than PrMC students.  Fig. c Comparison of perceived stressor domains between private and public medical students Inference: Medical students primarily experienced stress from academic and teaching-related demands, with these stressors being more pronounced among students attending the public medical college.	Evidence: Academic and Curricular Stressors: <i>"We have classes six days a week... Classes run from 7:30 in the morning until 2:30 in the afternoon. After that, we often have two items scheduled for the next day, and preparing for them is enormously stressful. Friday is the only day off, and then on Saturday they schedule two or three items."</i> [R3, M, FGD01, PrMC] <i>"Monotonous. Six-day week. Friday consumed by Saturday item prep. Continuous cycle of items, cards, terms."</i> [R2, F, FGD04, PbMC] <i>"Teacher-specific biased assessment -- must say exactly what this teacher prefers, from this book, this author. Cannot explain in own words."</i> [R5, F, FGD05, PbMC] Institutional Power & Culture stressors: <i>"Seniors periodically take juniors to sittings where demoralizing remarks are made, causing significant mental stress."</i> [R1, M, FGD01, PrMC] <i>"Hostel harassment by seniors — demanding explanations for absences, threatening to remove seats."</i> [R6, F, FGD05, PbMC] Social & Environmental Stressors <i>"Society and parents glorify medicine, driving enrolment under pressure. Medicine is seen as a humanitarian service, not a profession."</i> [R4, M, FGD02, PrMC] <i>"My parents sold land for my admission. Every time I fail a card, I do not just think about the exam — I think about what they gave up. That is heavier than the syllabus."</i> [R7, F, FGD04, PbMC] Inference: Medical students perceived stress as a multidimensional phenomenon arising from interacting academic, institutional, and social demands.	Confirmation and complementary: The quantitative findings identified academic-related and teaching and learning-related stressors as the predominant stressor domains. The qualitative findings confirmed these findings while complementing them by demonstrating that students experienced academic stress within a broader institutional and social context. Meta inference: Medical students perceived stress as a product of interacting academic, institutional, and social demands. Academic and teaching-related stressors constituted the predominant burden in the quantitative findings and were more pronounced among public medical college students. The qualitative data suggest broader institutional and social environments reinforced academic stressors.

Independent factors associated with perceived stress:

A multivariable Ordinary Least Squares (OLS) linear regression examined the PSS-10 total score, with gender, academic year, institution, age, and six MSSQ-40 domain scores as predictors. The model was significant ($F(11,189) = 12.57, p < 0.001$), explaining 42.2% of variance in perceived stress ($R^2 = 0.422$; adjusted $R^2 = 0.389$). Female sex ($\beta = -0.176, p = 0.002$), attending a private medical college ($\beta = -0.244, p < 0.001$), academic-related stressors ($\beta = 0.421, p < 0.001$), and social-related stressors ($\beta = -0.241, p = 0.002$) were independently associated with perceived stress. Although social-related stressors showed a weak positive association in the bivariate analysis, the regression coefficient became negative after adjustment for predictors. Age, academic year, and remaining MSSQ-40 domains were not independently associated after adjustment (all $p > 0.05$). Model diagnostics indicated no problematic multicollinearity (maximum VIF = 2.46), approximately normal distribution, acceptable homoscedasticity, and no highly influential observations (Table 13)

Table 13. Multivariable Linear Regression — Predictors of PSS-10 Total Score (N = 201)

Predictor	B	SE	β	t	p	Sig.	95% CI [Lower, Upper]
(Constant)	31.237	8.286	—	3.770	.000	***	[14.893, 47.582]
Female (vs Male)	-2.250	0.733	-.176	-3.071	.002	**	[-3.696, -0.805]
2nd Year (vs 1st Year)	0.808	0.872	.064	0.927	.355	ns	[-0.912, 2.528]
3rd Year (vs 1st Year)	1.839	1.134	.137	1.622	.106	ns	[-0.397, 4.076]
PrMC (vs PbMC)	-3.014	0.754	-.244	-3.996	.000	***	[-4.502, -1.526]
Age (years)	-0.763	0.391	-.148	-1.953	.052	ns†	[-1.534, 0.008]
MSSQ ARS	4.090	0.844	.421	4.848	.000	***	[2.426, 5.754]
MSSQ IRS	-0.349	0.668	-.044	-0.523	.602	ns	[-1.667, 0.968]
MSSQ TLRS	1.088	0.799	.118	1.361	.175	ns	[-0.489, 2.665]
MSSQ SRS †	-2.508	0.797	-.241	-3.148	.002	**	[-4.080, -0.937]
MSSQ DRS	0.600	0.432	.086	1.389	.167	ns	[-0.252, 1.452]
MSSQ GARS	1.280	0.672	.144	1.905	.058	ns†	[-0.046, 2.606]

*Note. B = unstandardised coefficient; SE = standard error; β = standardised coefficient; CI = confidence interval; t = t-statistic. Significance: *** $p < .001$, ** $p < .01$, * $p < .05$, ns = not significant, Variables approaching statistical significance ($0.05 \leq p < 0.10$) are marked with †.*

410 Across all FGDs, participants described academic and curricular demands as the primary sources of stress.
411 They explained that institutional conditions and availability of organisational and social support influenced these
412 stressors' intensity and persistence. These narratives complemented regression findings by providing explanations
413 for factors independently associated with perceived stress in the study.

414 **Integrated findings:**

415 Across all FGDs, participants consistently described academic and curricular demands as the primary
416 sources of stress. They further explained that institutional conditions contributed to students' stress experiences,
417 whereas the availability of organizational and social support influenced their capacity to cope with these
418 challenges. Together, these narratives complemented the regression findings by providing contextual explanations
419 for the factors that were independently associated with perceived stress (Table 14).

Table 14: Joint Display Table showing multilevel factors independently associated with perceived stress

Latent construct	Quantitative Evidence & Inference	Qualitative Evidence & Inference	Type of Integration with rationale & Meta-inference
Multilevel factors independently associated with perceived stress	Evidence: Multivariable linear regression showed the Female gender ($\beta = -0.176$, $p = 0.002$), attending the private medical college ($\beta = -0.244$, $p < 0.001$), academic-related stressors ($\beta = 0.421$, $p < 0.001$), and social-related stressors ($\beta = -0.241$, $p = 0.002$) were independently associated with perceived stress. Conversely, age, academic year, and the remaining MSSQ domains were not independently associated after adjustment (all $p > 0.05$). Inference: The academic-related stressors domain was the strongest independent factor associated with perceived stress. After controlling for other variables, gender and type of institution were found to contribute independently, suggesting perceived stress is influenced by both individual character and institutional context.	Synthesis of evidence: Across all FGDs, participants consistently described perceived stress as arising from interacting academic, institutional, and social environments. Respondents discussed academic and curricular stressors more prominently. Evidence: “<i>Medical life feels motionless. Pass one exam, next appears next day. No sense of forward movement.</i>” [R6, M, FGD04, PbMC] “<i>Financial burden grows each year. Boys feel pressure to provide.</i>” [R1, F, FGD04, PbMC] “<i>Other colleges have an indoor zone, sports field, common room. Food more expensive than other colleges — feels guilty about admission.</i>” [R4, M, FGD04, PbMC] “<i>Pressure nearly doubles or triples each year. No prior warning — mental preparation was not possible.</i>” [R1, M, FGD02, PrMC] Inference: Students perceived stress as arising from interacting personal, academic, institutional, and social contexts rather than from any single factor in isolation.	Confirmatory and complementary: The qualitative findings confirmed the central role of academic-related stressors identified in the regression model while complementing the quantitative findings by demonstrating that these stressors were embedded within broader institutional and social environments. Meta inference: Perceived stress among medical students appears to be independently associated with academic-related stressors, individual characteristics, institutional and social context. The qualitative findings further indicate that these statistically identified factors operate within interacting academic, institutional, and social environments rather than as isolated determinants of stress.

Coping response pathways to perceived stress:

Participants' narratives indicated that although medical students recognized their stress and the need to manage it, their responses varied between actively adopting coping responses and perceiving substantial constraints that limited their ability to cope (Additional file 1, Table 15).

Active coping responses

Participants' active responses included both problem- and emotion-focused strategies. Problem-focused responses involved time-management techniques, such as the Pomodoro method, maintaining strategic attendance, maintaining a skip day, and seeking advice from senior peers to navigate academic challenges.

"Strategic attendance calculation — many absences but within 75% threshold."

[R2, F, FGD04, PbMC]

Emotion-focused responses included maintaining social connections, engaging in hobbies or recreational activities, and watching entertainment content to alleviate emotional distress.

Constrained coping responses

Beyond active responses, many participants described constrained responses, unable to initiate or sustain coping despite recognizing its benefits. Intensive academic schedules, institutional restrictions, and limited extracurricular opportunities constrained their coping. Some described forced endurance, viewing stress as unavoidable in medical education. They believed seeking help was inaccessible or socially discouraged.

"I know what I am feeling is not normal stress. I know I need help. But there is no one here to help and going outside feels like admitting you cannot handle medicine."

[R1, M, FGD03, PrMC]

Overall, the participants' narratives suggested that students' coping responses could not be fully described by the conventional distinction between problem-focused and emotion-focused coping responses alone. In addition to active coping responses, many students described constrained responses characterized by an inability

to initiate or sustain coping responses and, in some cases, forced endurance of persistent stress, highlighting the influence of contextual barriers on coping responses.

Participants' Recommendations for Reducing Stress

Participants consistently framed stress reduction as a responsibility of the medical education system rather than that of individual students, with recommendations spanning academic, institutional, environmental, and psychosocial domains. Their recommendations were organized into five subthemes under one overarching theme: Reorienting Medical Education Towards Student Well-being Through System-Level Reform (Additional file 1, Table 16).

Creating a Sustainable Academic Structure

Most participants' recommendations focused on restructuring the academic system to reduce excessive workload and extend the recovery period. Modifications included preparatory leave before the professional examination, an assessment schedule designated as "item days," a later start time for the first session, in-class breaks, and two days of relaxation. Some participants proposed extending the medical curriculum by one year. Respondents expressed concerns about reorganizing the curriculum to ensure more logical sequencing and lessen reliance on strict attendance requirements. Participants recommended expanding opportunities for research involvement and student teaching assistantships to enhance academic engagement. Moreover, they emphasized inclusion of recreational activity-related events in the academic curriculum.

Transforming Teaching and Learning Practices

However, participants perceived that restructuring the schedule alone would have limited impact unless accompanied by reforms in teaching and learning practices. They felt practical notebook transcription and rote memorization should be replaced with understanding-based learning. They emphasized standardized learning materials, an integrated learning system, reduced fragmentation of teaching content by teachers, and frequent training in clinical procedural skills. Mandatory pre-medical orientation classes were recognized by students as a means of mentoring their early medical college academic lives.

Strengthening Faculty Accountability and Educational Culture

Participants further argued that educational reforms would be difficult to sustain without changes in faculty attitudes and institutional accountability. Under an accountability structure, students advocated for teacher training in empathy and fostering a student-supportive educational culture. Simultaneously, they believed incorporating student input into the medical education management system through anonymous student feedback and confidential complaint channels would enhance learning opportunities and student welfare.

Building Supportive Learning Environments

Beyond curriculum and faculty practices, participants emphasized that a physical and social learning environment was important for students' well-being. Social recommendations include expanding extracurricular activities, sports events, cultural programs, and clubs to foster interaction. Physical recommendations focused on improving classroom and hostel infrastructure. However, they noted that overcrowded clinical groups hampered the learning environment.

Providing Accessible and Trustworthy Mental Health Support

Finally, respondents viewed mental health services as a supportive resource but regarded them as complementary, rather than substitutes, to educational reforms. Participants supported establishing these services but emphasized that they should be confidential, anonymous, accessible, and integrated into medical colleges. They recommended dedicated counselling services, peer counselling programmes, and outreach to students experiencing distress. However, some also doubted the effectiveness of standalone mental health support, as one respondent echoed the scenario as

“Structural reform needed — band-aid solutions will not work. Mental counselling might help now.” (R4, M, FGD04, PbMC)

These recommendations describe an interconnected institutional reform. Participants framed stress reduction as the medical education system's responsibility. They advocated coordinated changes to curriculum organization, teaching practices, faculty culture, learning environments, and student support services. This

system-oriented perspective guides interpretation of the study's implications for medical education policy and practice.

Discussion:

This convergent mixed-methods study estimated the prevalence and distribution of perceived stress and its associated stressors among undergraduate medical students. It integrates the findings with qualitative narratives to comprehensively understand coping resources, coping response pathways, and participants' recommendations for enhancing student well-being. Overall, a substantial proportion of students experienced moderate to high levels of perceived stress across most demographic and academic subgroups, except for institutional enrolment and sex. Academic-related stressors emerged as the predominant source of stress, followed by teaching- and learning-related stressors. Multivariable analysis further demonstrated that female sex and enrolment in a private medical college were independently associated with lower perceived stress, whereas academic-related stressors were independently associated with higher perceived stress.

The prevalence of stress in this study was consistent with the findings of previous reports from South Asian countries. Globally, the reported prevalence of stress varies from approximately 20% to 92% [7, 8, 11, 21-24]. However, the stress measurement instruments and cut-off values differed between the studies. Stress and related psychological distress were measured using the General Health Questionnaire (GHQ-12), Perceived Stress Scale (PSS-14), and Depression, Anxiety, and Stress Scale (DASS-21), reflecting methodological heterogeneity and possibly explaining the prevalence variation of stress across studies [7, 8, 11, 21-24]. In addition, variability across educational systems in the study settings may have contributed to this wide range of prevalence.

The synthesis of previous studies showed that the severity of perceived stress consistently spanned moderate to high ranges [7, 8, 11, 21-24]. Our qualitative findings further indicated that students regard organizational support, accessible mental health services, and supportive peer environments as essential resources for coping with stress. However, in the absence of formal institutional support, they predominantly relied on informal support from family and peers. Our findings reinforce the long-standing recommendations of the General

Professional Education of the Physician (GPEP) Report by the Association of American Medical Colleges (AAMC), which advocates for integrating structured personal and professional development programs into undergraduate medical education to strengthen students' ability to cope with the demands of medical training [25]. Similarly, a Malaysian medical school that incorporated a longitudinal personal and professional development programme from the inception of the undergraduate curriculum reported a comparatively lower prevalence of stress (29.6%) [7]. Although direct comparisons should be interpreted cautiously because of differences in study design and measurement, this observation is consistent with the potential value of providing structured institutional support.

Consistent with studies from South and Southeast Asian countries, including Bangladesh, Malaysia, India, Pakistan, and Nepal, academic-related stressors predominated as a source of stress among our study participants, followed by teaching- and learning-related stressors [7, 8, 11, 21, 23, 24, 26]. Previous studies have identified non-academic contributors, including emotional distress, inadequate physical learning environments, limited opportunities for social interaction, and insufficient recreational activities. Our integrated mixed-methods analysis confirms and extends these findings, demonstrating that medical student stress stems from interconnected academic, institutional, and social environments, rather than academic demands alone. This understanding is supported by our content mapping analysis, which shows that although the MSSQ-40 captures major stressor domains, it does not fully reflect the stress experiences of Bangladeshi medical students. Seven qualitatively coded stressors were absent from the questionnaire, whereas nine MSSQ-40 items were not supported by the participants' narratives. Collectively, these findings support the need for a contextual evaluation and possible refinement of the MSSQ-40 for Bangladeshi medical students.

An unexpected finding was the inverse association between social-related stressors and perceived stress after multivariable adjustment, despite a positive bivariate correlation. This pattern suggests a suppressor effect, with the SRS domain's unique variance differing from its unadjusted association after accounting for its overlap

with other MSSQ domains. Qualitative findings highlighting peer relationships as coping resources explain this observation; however, this interpretation remains exploratory and requires confirmation.

The institutional differences observed in this study are consistent with previous findings from Bangladesh, suggesting that students in public medical colleges experience greater stress than those in private institutions [11]. However, our findings regarding sex differed from those of previous Bangladeshi studies. While earlier studies reported little or no sex differences in stress levels, our multivariable analysis showed that being female was independently associated with lower perceived stress [8, 11]. In contrast, a Pakistani study reported significantly higher perceived stress among female medical students [26]. These inconsistencies may reflect differences in the study populations, stress measures, and statistical adjustments.

Our findings suggest that students' coping experiences were not fully captured by the conventional distinction between problem-focused and emotion-focused coping responses. While students reported both problem-focused and emotion-focused coping responses, many identified constrained coping responses as well. Despite recognizing the need for stress management, academic demands, institutional constraints, and insufficient organizational support often hinder their ability to initiate or maintain effective coping responses. Consequently, some students described forced endurance, viewing stress as an inevitable aspect of medical education. This aligns with Lazarus and Folkman's Transactional Theory of Stress and Coping, which posits that coping responses are influenced by individuals' appraisal of stressors and the resources available to manage them [14]. Similar patterns have been reported in Southeast Asia, where some medical students accepted stress without actively attempting to cope, exemplified by "solitary and silent forbearance," while others perceived available coping responses as ineffective [11, 21, 24].

Strengths and limitations:

Employing a convergent mixed-methods approach, this study integrated quantitative and qualitative findings to provide a comprehensive understanding of the prevalence, associated factors, stressors, coping responses, and suggestions concerning stress among medical students. The inclusion of both public and private medical institutions facilitated an understanding of varied institutional environments. Utilizing validated tools

such as the Perceived Stress Scale (PSS-10) and the Medical Student Stressor Questionnaire (MSSQ-40), together with qualitative content mapping, strengthened the interpretation of context-specific stress experiences and highlighted potential limitations in the applicability of the MSSQ-40 in Bangladesh.

Nevertheless, this study has certain limitations. Since the PSS-10 and MSSQ-40 rely on self-reported data, the findings may be subject to reporting and social desirability bias, and students may have underreported sensitive coping responses, such as substance use. The study was limited to two medical colleges (one public and one private) in Dhaka, which could affect the generalizability of the results. However, a random sampling method was employed in the quantitative survey to minimize selection bias. One FGD included only male participants, and another had fewer participants than planned, which may have limited the breadth of perspectives obtained. However, thematic saturation was achieved across homogeneous participant groups. The researchers acknowledged that their medical and public health backgrounds could influence data collection and interpretation. Despite these limitations, the integration of quantitative and qualitative evidence provides a comprehensive understanding of medical students' stress experiences and offers contextually relevant insights to inform institutional strategies for enhancing student well-being and medical education in Bangladesh.

Conclusions:

This convergent mixed-methods study found that perceived stress is highly prevalent among undergraduate medical students and is shaped by interconnected academic, institutional, and social environments rather than by academic demands alone. Many students experienced constrained coping responses because intensive curricular demands, institutional barriers, and limited organizational support hindered their ability to initiate or sustain effective coping strategies. Although stressors related to academics, sex, institutional settings, and social contexts were found to be independently linked to perceived stress, these elements operate within interconnected educational environments rather than as isolated determinants of perceived stress. These findings underscore the importance of reorienting medical education towards student well-being through system-level reforms, such as curriculum optimization, fostering supportive institutional cultures, and providing accessible mental health services, rather than relying solely on interventions aimed at enhancing individual resilience.

Abbreviations:

ARS: Academic-Related Stressors

DRS: Drive- and Desire-Related Stressors

FGD: Focus Group Discussion

GARS: Group Activities-Related Stressors

IRS: Intrapersonal and Interpersonal-Related Stressors

MSSQ-40: Medical Student Stressor Questionnaire (40-item version)

OLS: Ordinary Least Squares

PbMC: Public Medical College

PrMC: Private Medical College

PSS-10: 10-item Perceived Stress Scale

SD: Standard Deviation

SRS: Social-Related Stressors

TLRS: Teaching and Learning-Related Stressors

VIF: Variance Inflation Factor

Acknowledgements:

We are deeply thankful to the authorities of both medical colleges for their kind cooperation and administrative support during the implementation of the study. We also acknowledge the valuable contributions of the project staff, data collection team, moderators, note-takers, and data analysts for their dedication and sincere efforts throughout the research process. Finally, we express our heartfelt appreciation to all participating medical students for their time, cooperation, and valuable insights, without which this study would not have been possible.

Authors contribution:

INN conceived and designed the study, developed the study protocol and data collection instruments, supervised data collection, conducted the quantitative and qualitative data analyses, integrated the quantitative and qualitative findings, interpreted the results, and drafted the manuscript. **ZR** and **SA** participated in data

collection, facilitated the focus group discussions, prepared field notes, performed initial coding and thematic analysis, and critically reviewed the manuscript. **IR** supervised qualitative data collection, contributed to the interpretation of the findings, and critically revised the manuscript. **NI** contributed to the study design, development of the study protocol, quantitative and qualitative data analyses, and manuscript drafting. **NAR**, **SKR**, and **DDDP** contributed to the study design, interpretation of the findings, and critical revision of the manuscript. **All authors** critically reviewed the manuscript, approved the final version for publication, agreed to its submission to **BMC Medical Education**, and accepted responsibility for all aspects of the work.

Funding:

This study was supported by a grant from the Bangladesh Medical Research Council (BMRC). Funding covered field activities, not publication or article processing charges.

Data availability:

The quantitative datasets supporting the conclusions of this article are included within the article and its supplementary files (Additional file 2). The de-identified qualitative transcripts generated and analysed during the current study are available from the corresponding author upon reasonable request, subject to ethical and confidentiality considerations. The qualitative codebook and supporting quotations are included in the supplementary files (Additional file 3).

631 **Declarations**

632 **Ethics approval:**

633 Ethical approval for the study was obtained from the Bangladesh Medical Research Council (BMRC)
634 Ethical Review Committee (Ref: BMRC/NREC/2025-2026/646(01-168), dated: 15/04/2026). Before
635 commencing data collection, institutional permission was obtained from the respective authorities of both medical
636 colleges.

637 **Consent to participate:**

638 Participation in the study was entirely voluntary. Written informed consent was obtained from all
639 participants before the quantitative and qualitative data collection. During focus group discussions (FGDs),
640 participants were requested to respect the privacy of other participants and maintain the confidentiality of the
641 discussion content. The sessions were audio-recorded with the permission of all respondents.

642 **Consent to publish:**

643 Participants were informed about the process of anonymity and confidentiality during the reporting of the
644 study. No personal identifiers were included in the dataset, report, or publication. In addition, the FGD participants
645 provided additional informed consent for the publication of their anonymized verbatim quotations.

646 **Competing interests:**

647 The authors declare no competing interests.

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