Research Article

International Journal of Pediatric Health and Neonatal Sciences

Temporal Trends in Depression, Anxiety and Stress among First-Year Medical and Engineering Students: A Longitudinal Comparative Study in Eastern India

Dr. Avijit Mondal[1*], Dr. Mandrita Chatterjee[2] and Dr. Oona Chakrabarty[3]

[1]*Associate Professor, Physiology, Dr. B.C. Roy Multi-Speciality Medical Research Centre, IIT Kharagpur, India.*

[2]*Assistant Professor, Physiology, Dr. B.C. Roy Multi-Speciality Medical Research Centre, IIT Kharagpur, India.*

[3]*Associate Professor, Physiology, Diamond Harbour Government Medical College and Hospital, Diamond Harbour, India.*

***Corresponding author**

Dr. Avijit Mondal,
Associate Professor, Physiology, Dr. B.C. Roy Multi-Speciality Medical Research Centre, IIT Kharagpur, India.

Submitted: 10 Nov 2026; **Accepted:** 16 Nov 2026; **Published:** 27 Nov 2026

Citation: Mondal, A., Chatterjee, M., & Chakrabarty, O. (2026). Temporal Trends in Depression, Anxiety and Stress among First-Year Medical and Engineering Students: A Longitudinal Comparative Study in Eastern India. *Int. J. Pediatr. Health Neonatal Sci., 1*(1):1-6.

Abstract

Background: *Psychological distress is reported among university students in demanding professional programmes. However, longitudinal comparisons of medical and engineering students across the academic year are limited. Objective: To compare depression, anxiety and stress symptoms among first-year medical and engineering students at three academic time points.*

Methods: *This institution-based longitudinal observational study followed 200 first-year students (100 medical and 100 engineering) at the beginning, middle and immediately before the final/professional examination period of the academic year. Symptoms were assessed using the Depression, Anxiety and Stress Scale-21 (DASS-21). Paired comparisons examined within-group changes, and generalized estimating equation (GEE) models with robust standard errors assessed group, time and group-by-time effects, adjusting for age, sex, accommodation and family type.*

Results: *All participants completed the three assessments. Mean depression, anxiety and stress scores were highest before examinations in both cohorts. From mid-year to pre-examination, all three scores increased significantly in medical and engineering students (all $p \leq 0.005$). The adjusted group-by-time interaction was significant for depression (Wald $\chi^2=14.85$, $p=0.0006$), but not anxiety ($p=0.336$) or stress ($p=0.198$).*

Conclusion: *Psychological distress fluctuated across the academic year, with a consistent pre-examination increase in both cohorts. The findings support accessible student mental-health services across professional programmes, with intensified preventive support during high-pressure assessment periods.*

Keywords: Depression; Anxiety; Psychological stress; Medical students; Engineering students; Longitudinal study; DASS-21.

Introduction

Psychological distress, including depressive, anxiety and stress symptoms, is frequently reported among university students. Recent evidence syntheses indicate a substantial burden, although prevalence estimates vary considerably with population, instrument, cut-off and study setting [1,2]. Medical students have been a particular focus of research: a systematic review and meta-analysis reported a pooled prevalence of depressive symptoms of 27.2%, alongside substantial heterogeneity between studies [3]. Earlier reviews have likewise documented psychological distress during medical training [4,5].

Students enrolled in professional programmes may encounter academic workload, competitive assessment, transition-related demands and uncertainty about future careers. Indian studies have documented stress among medical and other professional-course students [6,7], while recent research among engineering undergraduates has highlighted academic stress, amotivation and coaching-related pressures [8]. Indian medical-student studies have also reported depression, anxiety and stress, including assessments conducted near examinations [9,10]. These findings suggest that psychological distress should not be considered exclusive to one professional stream.

Despite the growing literature, direct comparisons of depression, anxiety and stress between medical and engineering students, using the same instrument and repeated assessments during the same academic year, remain relatively limited. The present study therefore compared DASS-21 scores in first-year medical and engineering students at the beginning, middle and pre-examination periods. The study also explored associations with selected demographic characteristics.

Rationale

A repeated-measures comparison may help distinguish distress that is common across professional education from changes

that differ between academic streams. The three assessment points were selected to capture early adjustment, the middle of the academic year and the period immediately preceding final/ professional examinations.

- at the beginning of their academic year,
- during the middle of academic year, when they have begun to cope with the challenges faced in their respective fields,
- before they face their Final Examination.

This study aims to assess the psychological stress, depression, anxiety, in a) First year undergraduate Engineering students in a World class institute in Eastern India and b) First year undergraduate medical students in a Government Medical College in Eastern India, and compare and contrast among them. Therein lies the focus area of this study.

Study Objectives

The principal objectives of this study were:

1. To find the prevalence of depression, anxiety, stress, of both medical and engineering students in eastern India at 3 different phases of their first academic year.
2. To find out the principal contributing factors which causes depression, anxiety and stress and their association with demographic factors
3. Compare and contrast psychological stress, depression and anxiety in First year undergraduate Engineering and medical students.

Methods

- **Study design:** Longitudinal observational study with repeated measures; the same participants were assessed at three time points. [16].
- **Sampling:** Complete enumeration of eligible first-year students in the participating institutions.
- **Target population:** All healthy medical and engineering students.
- **Study population:** Young healthy medical students of a State Government Medical College & Hospital and young healthy engineering students of an Engineering Institute of National Importance in West Bengal.

Inclusion criteria

- Participants having normal general health aged between 18-30 years.
- Medical and engineering students who gave informed written consent.

Exclusion criteria

Participant with any known Psychiatric/Neurologic illness.

Study area

Department of Physiology of Dr. B.C. Roy Multi Speciality Medical Research Centre, IIT Kharagpur.
Department of Physiology of Diamond Harbour Government Medical College & Hospital.

- **Study duration:** 1 year

- **Study population:** All first year medical (MBBS) and engineering (B. Tech) students studying in a State Govt. Medical College & Hospital & an Engineering Institute of National Importance in West Bengal respectively were included in this study.
- **Recruitment of the participants:** All healthy young medical and engineering students between the age group of 18 to 30 years were eligible for being included in the study.

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Institutional Ethics Committee approval was obtained before commencement of the study. Written informed consent was obtained from all participants prior to enrolment.

Following the selection of participants, they filled up a set of questionnaires. They submitted it at 3 phases of the Academic Year-

- the beginning of their academic year,
- during the middle of their academic year, where they had begun to cope with the challenges faced in their respective fields, and
- before they faced their final examinations.

The Questionnaire were divided in 4 parts. The 1st part consisted of Demographic Details of the participant like Name, Age, Sex, Stream/ Specialization, Name of Institution, Accommodation: (Day scholar/Hosteller), Type of Family (Joint/ Nuclear).

The 2nd part of the Questionnaire assessed Depression, Anxiety, Stress of the Medical and Engineering students. The Depression Anxiety Stress Scales–21 Items (DASS-21) [12-15] is a set of three self-report scales designed to measure the emotional states of depression, anxiety and stress. Each of the three DASS-21 scales contains 7 items, divided into subscales with similar content. The depression scale assesses dysphoria, hopelessness, devaluation of life, self-deprecation, lack of interest / involvement, anhedonia and inertia. The anxiety scale assesses autonomic arousal, skeletal muscle effects, situational anxiety, and subjective experience of anxious affect. The stress scale is sensitive to levels of chronic non-specific arousal. It assesses difficulty relaxing, nervous arousal, and being easily upset / agitated, irritable / over-reactive and impatient. Scores for depression, anxiety and stress are calculated by summing the scores for the relevant items each DASS-21 subscale sum was multiplied by 2 before severity classification. The rating scale is as follows:

0 Did not apply to me at all
1 Applied to me to some degree, or some of the time
2 Applied to me to a considerable degree or a good part of time
3 Applied to me very much or most of the time

The self-reported Stress, Depression and Anxiety Severity Levels were interpreted as:

- **Depression:** 0-9 (Normal), 10-13 (Mild), 14-20 (Moderate), 21-27 (Severe), 28+ (Extremely Severe)

- **Anxiety:** 0-7 (Normal), 8-9 (Mild), 10-14 (Moderate), 15-19 (Severe), 20+ (Extremely Severe)
- **Stress:** 0-14 (Normal), 15-18 (Mild), 19-25 (Moderate), 26-33 (Severe), 34+ (Extremely Severe)

Statistical Analysis

Data were analysed using SPSS version 27.0 and GraphPad Prism version 5. Continuous variables are presented as mean ± standard deviation and categorical variables as frequency and percentage. Paired t-tests were used for within-participant comparisons between assessment periods. To account for correlation among repeated observations, separate Gaussian generalized estimating equation (GEE) models with robust standard errors and an exchangeable working correlation structure were fitted for depression, anxiety and stress. Models included group, assessment time, group-by-time interaction, age, sex, accommodation and family type. The group-by-time interaction was assessed using a joint Wald test. Because all engineering participants were hostellers, accommodation effects should be interpreted cautiously due to limited overlap between groups. Two-sided $p<0.05$ was considered statistically significant [16,17].

Result

Participants and baseline characteristics

All 200 participants (100 medical and 100 engineering students) completed all three assessments, yielding 600 participant-time observations. Mean age was 18.84 ± 1.24 years in medical and 18.54 ± 1.33 years in engineering students (p=0.100). Sex and family type distributions were similar. Accommodation differed: 34% of medical students were day scholars, whereas all engineering students were hostellers (p<0.001).

Table 1: Baseline demographic and accommodation characteristics

Characteristic	Medical (n=100)	Engineering (n=100)	p
Age, years (mean ± SD)	18.84 ± 1.24	18.54 ± 1.33	0.100
Female, n (%)	47 (47)	52 (52)	0.572
Day scholar, n (%)	34 (34)	0 (0)	<0.001
Joint family, n (%)	44 (44)	47 (47)	0.776

DASS-21 scores across the academic year

Mean ± SD scores were highest before examinations in both groups for all three domains.

Table 2: DASS-21 subscale scores by group and assessment time (mean ± SD)

Outcome	Group	Beginning	Mid-year	Pre-exam
Anxiety	Engineering	10.94 ± 3.22	9.30 ± 3.43	12.82 ± 3.60
Anxiety	Medical	10.12 ± 3.47	9.14 ± 3.70	12.68 ± 3.10
Depression	Engineering	10.00 ± 3.25	10.04 ± 3.23	12.82 ± 3.34
Depression	Medical	9.36 ± 3.55	8.86 ± 4.13	10.20 ± 3.69
Stress	Engineering	15.59 ± 3.90	14.95 ± 3.76	18.14 ± 4.27
Stress	Medical	14.48 ± 3.42	12.76 ± 3.71	16.46 ± 3.69

Within-group changes over time

Table 3: Paired comparisons of DASS-21 scores between assessment time points

Outcome	Group	Comparison	Mean difference (later − earlier)	t	p value
Depression	Engineering	Beginning to Mid-year	+0.04	-0.09	0.925
Depression	Engineering	Mid-year to Pre-examination	+2.78	-6.51	<0.001*
Depression	Engineering	Beginning to Pre-examination	+2.82	-7.74	<0.001*
Depression	Medical	Beginning to Mid-year	-0.50	1.11	0.269
Depression	Medical	Mid-year to Pre-examination	+1.34	-2.86	0.005*
Depression	Medical	Beginning to Pre-examination	+0.84	-2.23	0.028*
Anxiety	Engineering	Beginning to Mid-year	-1.64	3.90	<0.001*
Anxiety	Engineering	Mid-year to Pre-examination	+3.52	-8.56	<0.001*
Anxiety	Engineering	Beginning to Pre-examination	+1.88	-4.50	<0.001*
Anxiety	Medical	Beginning to Mid-year	-0.98	2.89	0.005*
Anxiety	Medical	Mid-year to Pre-examination	+3.54	-8.56	<0.001*
Anxiety	Medical	Beginning to Pre-examination	+2.56	-7.38	<0.001*
Stress	Engineering	Beginning to Mid-year	-0.64	1.40	0.163

Stress	Engineering	Mid-year to Pre-examination	+3.19	-6.74	<0.001*
Stress	Engineering	Beginning to Pre-examination	+2.55	-5.80	<0.001*
Stress	Medical	Beginning to Mid-year	-1.72	4.30	<0.001*
Stress	Medical	Mid-year to Pre-examination	+3.70	-8.24	<0.001*
Stress	Medical	Beginning to Pre-examination	+1.98	-4.63	<0.001*

Engineering students: depression was unchanged from beginning to mid-year (p=0.925) and increased before examinations (+2.78, p<0.001); anxiety decreased mid-year (−1.64, p<0.001) then increased (+3.52, p<0.001); stress decreased non-significantly (−0.64, p=0.163) then increased (+3.19, p<0.001). Medical students: depression was unchanged from beginning to mid-year (p=0.269) and increased before examinations (+1.34, p=0.005); anxiety decreased (−0.98, p=0.005) then increased (+3.54, p<0.001); stress decreased (−1.72, p<0.001) then increased (+3.70, p<0.001).

Adjusted repeated-measures analysis

Separate Gaussian GEE models with robust standard errors and exchangeable within-participant correlation adjusted for group, time, group×time, age, sex, accommodation and family type.

Table 4: Joint tests of the group-by-time interaction in adjusted GEE models

Outcome	Wald χ^2 (2 df), group×time	p
Depression	14.85	0.0006*
Anxiety	2.18	0.336
Stress	3.24	0.198

The group×time interaction was significant for depression, indicating different temporal trajectories between cohorts. Interactions were not significant for anxiety or stress. Adjusted medical-minus-engineering contrasts showed lower medical depression at mid-year (−1.35, p=0.019) and pre-examination (−2.79, p<0.001); lower anxiety only at baseline (−1.07, p=0.020); and lower stress at all three assessments (baseline −1.43, p=0.011; mid-year −2.51, p<0.001; pre-examination −2.00, p<0.001).

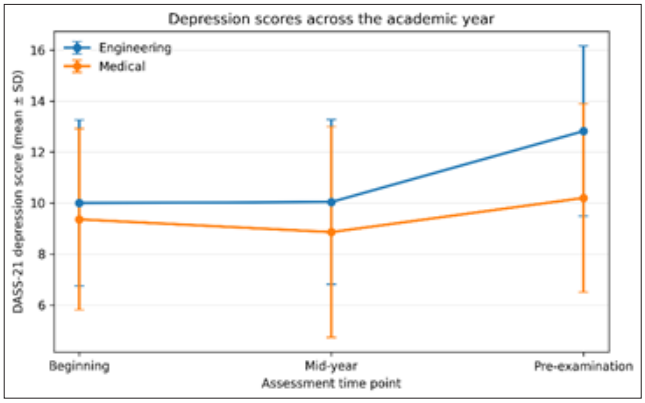

Figure 1: Mean depression scores at the beginning, middle and pre-examination assessments in engineering and medical students

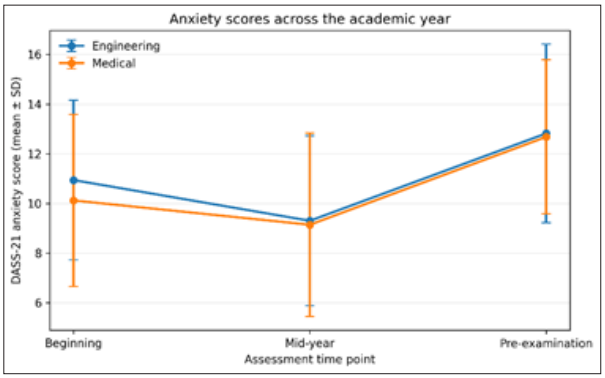

Figure 2: Mean anxiety scores at the beginning, middle and pre-examination assessments in engineering and medical students.

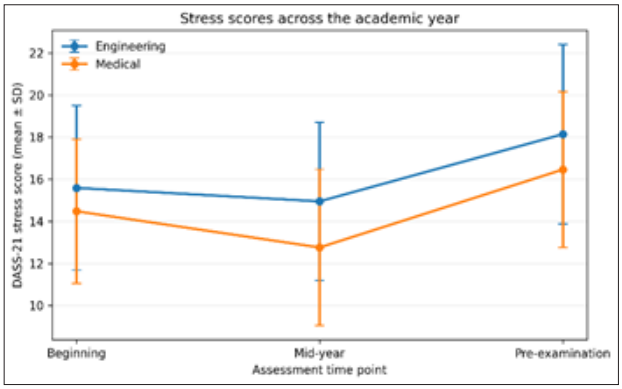

Figure 3: Mean stress scores at the beginning, middle and pre-examination assessments in engineering and medical students.

Discussion

The present longitudinal study compared depression, anxiety and stress among first-year medical and engineering students at three points during the academic year. The principal finding was a consistent increase in psychological distress before final/professional examinations in both cohorts. Depression, anxiety and stress scores increased significantly from mid-year to the pre-examination assessment in both groups. This pattern suggests that psychological distress among professional-course students is dynamic and may be influenced by the academic calendar and the demands associated with high-stakes assessments [1-5].

The observed increase in distress is consistent with evidence that psychological symptoms are common among university students. A recent umbrella review synthesizing 62 meta-analyses and more than 8.7 million participants reported substantial pooled estimates for depression, anxiety and stress, while emphasizing marked heterogeneity across studies [1]. A post-pandemic systematic review of 63 studies and more than

255,000 university students similarly documented a continuing burden of these symptoms [2]. Among medical students, Rotenstein et al. reported a pooled prevalence of depressive symptoms of 27.2%, while Dyrbye et al. described a broad burden of psychological distress during medical training [3,4]. These estimates should not be directly compared with the present scores because the populations, instruments, cut-offs and study designs differ.

The mid-year pattern differed slightly between cohorts. Engineering students showed a significant reduction in anxiety from the beginning to mid-year, whereas depression and stress did not change significantly. Among medical students, anxiety and stress decreased significantly, while depression did not. Adaptation to the academic environment, peer relationships and coping may be possible explanations, but these factors were not directly measured. Earlier Indian work has described stress among medical students and students from different professional courses [6,7,18-22]. Recent prospective evidence among first-year medical students also indicates that psychological symptoms may change during the transition into medical education [10].

An important finding was the absence of a uniform pattern of greater psychological distress in either professional group. The adjusted group-by-time interaction was significant only for depression ($p=0.0006$), and not for anxiety ($p=0.336$) or stress ($p=0.198$). This indicates different depression trajectories between cohorts, while temporal changes in anxiety and stress were broadly comparable. Indian research among engineering undergraduates has identified academic stress, amotivation and coaching experience as relevant correlates of mental health [8]. The present findings therefore support attention to psychological well-being across professional programmes.

Age was positively associated with stress scores, while students from nuclear families had higher adjusted stress scores than those from joint families. These associations are observational and should not be interpreted causally. Accommodation differed substantially: all engineering students were hostellers, compared with 66% of medical students. This lack of overlap limits separation of accommodation effects from programme and institutional effects.

The findings have implications for student-support services. Institutions should provide confidential, non-stigmatising counselling, peer-support initiatives and clear referral pathways, with proactive outreach before major examinations. Research among Indian medical students has described barriers to seeking mental-health care, including concerns about confidentiality and preferences for informal help-seeking [11]. Screening should facilitate appropriate assessment and support rather than assign clinical diagnoses based on questionnaire scores alone.

Several limitations should be acknowledged. Students were recruited from one medical college and one engineering institution, limiting generalisability and confounding programme with institutional context. Accommodation was imbalanced between groups. Academic workload, coping, sleep, social support and examination performance were not directly assessed. DASS-21 is a self-report symptom measure rather than a diagnostic interview [12-14].

Overall, psychological distress fluctuated during the first academic year, with a marked increase before examinations in both cohorts. These findings support institution-wide mental-health services and targeted preventive support during high-pressure academic periods.

Conclusion

The present longitudinal study demonstrates that depression, anxiety and stress symptoms fluctuate during the first academic year among medical and engineering students, with a consistent and significant increase in all three domains before final/professional examinations. Although some differences in adjusted scores were observed between the cohorts, neither group showed a uniformly greater burden across all outcomes and assessment periods. The findings highlight examination-related academic pressure as an important period for psychological vulnerability among students in both professional streams. Institutions should therefore implement accessible, confidential and non-stigmatising mental-health support services, with proactive screening and counselling during high-pressure academic periods. Further multicentre longitudinal studies incorporating academic, behavioural and psychosocial determinants are warranted to identify modifiable risk factors and develop effective student-support strategies.

Competing interests

The authors declare no competing interest.

Authors' Contributions

All authors equally contributed to the manuscript. All authors reviewed the manuscript.

References

1. Paiva, U., Cortese, S., Flor, M., Moncada-Parra, A., Lecumberri, A., Eudave, L., Magallón, S., García-González, S., Sobrino-Morras, Á., Piqué, I., Mestre-Bach, G., Solmi, M., & Arrondo, G. (2025). Prevalence of mental disorder symptoms among university students: an umbrella review. Neurosci Biobehav Rev, 175, DOI: https://doi.org/10.1016/j.neubiorev.2025.106244
2. Antón-Ruiz, J. A., Bernabé, M., & Heredia-Oliva, E. (2026). Prevalence of depression, anxiety, and stress among university students in the post-COVID-19 period: a systematic review and meta-analysis. *BMC Psychol, 14*(1), DOI: https://doi.org/10.1186/s40359-026-05066-4
3. Rotenstein, L. S., Ramos, M. A., Torre, M., Segal, J. B., Peluso, M. J., Guille, C., Sen, S., & Mata, D. A. (2016). Prevalence of depression, depressive symptoms, and suicidal ideation among medical students: a systematic review and meta-analysis. *JAMA, 316*(21), DOI: https://doi.org/10.1001/jama.2016.17324

4. Dyrbye, L. N., Thomas, M. R., & Shanafelt, T. D. (2006). Systematic review of depression, anxiety, and other indicators of psychological distress among U.S. and Canadian medical students. *Acad Med, 81*(4), DOI:https://doi.org/10.1097/00001888-200604000-00009
5. Peng, P., Hao, Y., Liu, Y., Chen, S., Wang, Y., Yang, Q., Wang, X., Li, M., Wang, Y., He, L., Wang, Q., Ma, Y., He, H., Zhou, Y., Wu, Q., & Liu, T. (2023). The prevalence and risk factors of mental problems in medical students during COVID-19 pandemic: a systematic review and meta-analysis. *J Affect Disord,* 321,167-181. DOI: https://doi.org/10.1016/j.jad.2022.10.040
6. Supe, A. N. (1998). A study of stress in medical students at Seth G.S. Medical College. *J Postgrad Med, 44*(1), 1-6. https://pubmed.ncbi.nlm.nih.gov/10703558/
7. Waghachavare, V. B., Dhumale, G. B., Kadam, Y. R., & Gore, A. D. (2013). A study of stress among students of professional colleges from an urban area in India. *Sultan Qaboos Univ Med J, 13*(3),429-436. https://pubmed.ncbi.nlm.nih.gov/23984029/
8. Maji, S., Chaturmohta, A., Deevela, D., Sinha, S., Tarsolia, S., & Barsaiya, A. (2024). Mental health consequences of academic stress, amotivation, and coaching experience: a study of India's top engineering undergraduates. *Psychol Sch, 61*(9), 3540-3566.
9. Babu, G., Gurupatham, D., & Rajasekaran, R. T. T. (2023). Prevalence of depression, anxiety, and stress among medical students before their final examinations at a private medical college of Tamil Nadu, India: a cross-sectional study. *J Clin Diagn Res, 17*(12), DOI: https://doi.org/10.7860/JCDR/2023/67589.18874
10. Mallaram, G. K., Gopalakrishnan, U., Mathews, D. A., Mudamala, D. S., Gangavarappagari, H., Modi, U., & Kattula, D. (2024). Stress, anxiety, and depression in the first-year students of medical education: a prospective cohort study from a women's medical college in South India. *Indian J Psychol Med*, DOI: https://doi.org/10.1177/02537176241282100
11. von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., & Vandenbroucke, J. P. (2007). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *PLoS Med. 4*(10), DOI: https://doi.org/10.1371/journal.pmed.0040296
12. Lovibond, S. H., & Lovibond, P. F. (1995). Manual for the Depression Anxiety Stress Scales (2nd ed.). Psychology Foundation of Australia.
13. Antony, M. M., Bieling, P. J., Cox, B. J., Enns, M. W., & Swinson, R. P. (1998). Psychometric properties of the 42-item and 21-item versions of the Depression Anxiety Stress Scales in clinical groups and a community sample. *Psychol Assess, 10*(2), 176-181. DOI:https://psycnet.apa.org/doi/10.1037/1040-3590.10.2.176
14. Henry, J. D., & Crawford, J. R. (2005). The short-form version of the Depression Anxiety Stress Scales (DASS-21): construct validity and normative data in a large non-clinical sample. *Br J Clin Psychol, 44*(Pt 2), 227-239. DOI: https://doi.org/10.1348/014466505x29657
15. Crawford, J. R., & Henry, J. D. (2003). The Depression Anxiety Stress Scales (DASS): normative data and latent structure in a large non-clinical sample. *Br J Clin Psychol, 42*(Pt2), 111-131. DOI: https://doi.org/10.1348/014466503321903544
16. Liang, K. Y., & Zeger, S. L. (1986). Longitudinal data analysis using generalized linear models. *Biometrika, 73*(1), 13-22. DOI: https://doi.org/10.1093/biomet/73.1.13
17. Zeger, S. L., Liang, K. Y., & Albert, PS. (1988). Models for longitudinal data: a generalized estimating equation approach. *Biometrics, 44*(4), 1049-1060. DOI: https://doi.org/10.2307/2531734
18. Kessler, R. C., Berglund, P., Demler, O., Jin, R., Koretz, D., Merikangas, K. R., Rush, A. J., Walters, E. E., & Wang, PS. (2003). The epidemiology of major depressive disorder: results from the National Comorbidity Survey Replication (NCS-R). *JAMA, 289*(23), 3095-3105. DOI: https://doi.org/10.1001/jama.289.23.3095
19. Patil, S. P, Sadhanala, S., & Bansode-Gokhe, S. S. (2018). Study of depression, anxiety and stress among undergraduate medical students of a teaching medical institution. *Natl J Community Med, 9*(8), 604-608.
20. Kamboj, G., Nilika, & Bhartiya, S. (2021). Prevalence of stress, anxiety and depression in undergraduate medical students: a cross sectional study. *Int J Community Med Public Health, 8*(3), 1175-1180. DOI:https://doi.org/10.18203/2394-6040.ijcmph20210846
21. Gupta, S., Potdar, P., Singh, R., & Shukla, K. K. (2022). A cross sectional study on depression, anxiety and stress among the first-year medical students. *Int J Community Med Public Health, 9*(3), 1400-1405. DOI:https://doi.org/10.18203/2394-6040.ijcmph20222020
22. Arun, P., Ramamurthy, P., & Thilakan, P. (2022). Indian medical students with depression, anxiety, and suicidal behavior: why do they not seek treatment? *Indian J Psychol Med, 44*(1), 10-16. DOI: https://doi.org/10.1177/0253717620982326

Copyright: ©2026 Avijit Mondal. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.