

Educational Stress and Depressive Symptoms among Undergraduate Medical Students: Dimensions, Correlates and Variation across Professional Year

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Abstract

Background

Medical training exposes students to sustained academic and professional demands, but how educational stress relates to depressive symptom burden across professional years remains incompletely understood. This study examined educational stress in relation to depressive symptoms, its empirical dimensions, and variation across professional years.

Methods

A cross-sectional analytical study was conducted among 466 undergraduate medical students at a tertiary-care teaching institution in northern India during May–June 2024. Students were selected by proportionate stratified random sampling. Educational stress was measured using the 33-item Higher Education Stress Inventory (HESI) and depressive symptoms with the Beck Depression Inventory-II (BDI-II). Because the optional sexual-interest item was unanswered by 159 students, continuous analyses used the 20 BDI-II items completed by all participants (BDI-20); complete 21-item severity categories were described among complete responders. Analyses included reliability testing, correlation, robust multivariable linear regression, HESI-by-professional-year interaction testing, exploratory factor analysis with parallel analysis, and an exploratory nonlinear predictive analysis.

Results

Mean HESI score was 56.0 ± 11.8 (Cronbach $\alpha = 0.821$), and mean BDI-20 score was 16.7 ± 11.0 . Eighty students (17.2%) endorsed suicidal thoughts or wishes. Educational stress correlated with depressive symptom burden ($r = 0.316$, $P < 0.001$). The association varied across professional years after adjustment (joint interaction Wald $\chi^2 = 10.43$, $df = 3$, $P = 0.015$), with the strongest unadjusted correlations in first ($r = 0.437$) and final year ($r = 0.472$). Parallel analysis supported three empirical HESI dimensions. Poor educational support/professional fulfilment (adjusted standardized $\beta = 0.190$, 95% CI 0.094–0.287) and future/financial/professional concerns ($\beta = 0.094$, 95% CI 0.006–0.182) were independently associated with depressive symptom burden; the demanding/impersonal learning-environment dimension was not. Lower life satisfaction, greater loneliness and greater social-media use were associated with both outcomes, while adequate sleep was inversely associated with depressive symptom burden.

Conclusions

Educational stress was related to depressive symptom burden, and the strength of this relationship varied across professional years. Educational support, professional fulfilment and future-oriented

concerns may be more informative than a single total stress score. Longitudinal studies are needed to determine whether these associations are temporal and modifiable.

Introduction

Medical training exposes students to a combination of high academic load, frequent assessment, transition to clinical responsibility, uncertainty about future competence and the social demands of professional formation. These pressures occur during early adulthood, when many students are simultaneously adapting to independent living and new peer environments. Psychological distress in medical students is therefore not simply an individual clinical issue; it also concerns the educational environment in which training occurs. In India, a 2023 systematic review and meta-analysis of 19 studies involving 5,944 undergraduate medical students estimated a pooled prevalence of depression of 50%, although the wide confidence interval and marked between-study heterogeneity caution against treating this as a single national rate.¹ A subsequent Indian meta-analysis published in 2024 similarly documented a substantial burden of depression, anxiety, stress and suicidal ideation among medical undergraduates.² Recent synthesis of systematic reviews likewise identifies academic stress, poor sleep and early stages of training among recurring correlates of depressive and anxiety symptoms in medical students.³

Educational stress deserves separate attention because it is potentially closer to the training environment than general perceived stress. The Higher Education Stress Inventory (HESI), originally developed in medical students, captures stressors such as workload, feedback, support, educational climate, finances and worries about future professional competence.⁴ Later large-scale validation confirmed that HESI is multidimensional and that its scores are related to depressive symptoms and quality of life.⁵ Indian studies have also shown that the nature of educational stress changes across the curriculum. In a North Indian medical university, financial concerns were prominent early in training, faculty shortcomings and inadequate feedback were prominent in the second year, and worries about future endurance and competence were greatest in final-year students.⁶

Existing Indian work has established that educational stress and psychological morbidity are related. Saxena et al. found positive correlations of educational stress with depression and anxiety among professional undergraduates, with differences between early and later professional years of medical education.⁷ More recent Indian evidence continues to identify academic demands, social isolation, limited recreation and transition to clinical training as important features of student distress.⁸ The introduction of competency-based medical education has altered the structure of undergraduate training, but available evidence does not show a uniform reduction in depression or stress.⁹ Similar concerns extend beyond undergraduate education; a recent North Indian study among postgraduate medical students reported a substantial burden of perceived stress in relation to academic, workplace, sleep and lifestyle factors.¹⁰

The remaining question is therefore less about whether medical students experience stress and more about how educational stress relates to depressive symptom burden. Total HESI scores can conceal differences between educational support, workload, professional uncertainty and financial concerns. Similarly, dichotomising depressive symptoms sacrifices information about symptom burden. The stress–depression relationship was therefore examined continuously, with assessment of variation by professional year and exploration of the empirical dimensions of educational stress within the same cohort. A secondary sensitivity analysis examined whether a compact nonlinear neural-network model improved prediction beyond a regularized linear benchmark.

The primary objective was to examine the relationship between educational stress and depressive symptom burden among undergraduate medical students and to assess whether this relationship varied across professional years. Secondary objectives were to examine the dimensional structure of educational stress and the associations of empirically derived dimensions with depressive symptom burden, and to identify shared and distinct academic, lifestyle and psychosocial correlates of educational stress and depressive symptoms.

Methods

Study design and setting

A cross-sectional analytical study was conducted over two months, from May to June 2024, among undergraduate MBBS students at a tertiary-care teaching institution in northern India. Students enrolled in all four professional years during the 2024 academic session constituted the study population.

Study population and sampling

The sample size was estimated using the prevalence of depression of 71.25 per cent reported by Kumar et al. among medical students.¹¹ Using the single-population proportion formula, $n = Z^2pq/d^2$, with a 95 per cent confidence level and an absolute precision of 5 per cent, the minimum required sample size was approximately 315 students. To improve representation across all four professional-year strata and increase the precision of stratum-specific analyses, recruitment was extended beyond the minimum requirement. A total of 466 undergraduate medical students were included in the study. Proportionate stratified random sampling was used, with each professional year treated as a stratum and students selected proportionately from the four batches using computer-generated random numbers.

Undergraduate MBBS students from the selected batches who consented to participate were eligible. Students on leave for more than one month because of health or personal reasons, and students whose admission had been cancelled or who were no longer part of the regular batch, were excluded.

Study instrument

Data were collected through a predesigned, pretested, anonymous, self-administered structured questionnaire using Google Forms. The questionnaire was pilot-tested among 30 medical students who were not included in the final analysis to assess clarity, comprehensibility and feasibility, and minor modifications were made before the main survey. The questionnaire covered sociodemographic and academic characteristics; family and living conditions; sleep, leisure and substance use; social-media use and other psychosocial characteristics; educational stress; and depressive symptoms. Randomly selected students were informed about the purpose of the study before participation. No name, email address or other direct personal identifier was collected.

Educational stress

Educational stress was assessed using the 33-item HESI.⁴ Items were rated on a four-point response scale. Positively worded items were reverse-scored so that higher total scores consistently represented greater educational stress. The instrument was analysed as a continuous measure; no arbitrary stress cut-off was imposed because HESI was designed to characterize educational stressors rather than diagnose a disorder.

Depressive symptoms and missing-item handling

Depressive symptoms were assessed with the 21-item BDI-II.¹² All 466 participants answered the first 20 items, while the optional item concerning loss of interest in sex was unanswered by 159 students. Non-response to this item was not treated as absence of the symptom. Accordingly, higher continuous analyses used the sum of the 20 universally completed items (BDI-20). Full 21-item BDI-II severity categories were reported only among students with complete responses to all 21 items ($n = 307$). The suicidal-thought item was also described separately because of its clinical importance.

Psychometric analysis of HESI

Internal consistency was assessed using Cronbach's alpha. Suitability for factor analysis was examined using the Kaiser–Meyer–Olkin statistic and Bartlett's test of sphericity. Factor retention was guided by parallel analysis with 500 random replications¹³. Exploratory maximum-likelihood factor analysis with varimax rotation was used to examine the empirical structure of HESI in this sample. Factor scores from the fitted factor model were used in the subsequent regression analysis. Factor labels were assigned from the content of the higher-loading items and are descriptive; they should not be interpreted as newly validated HESI subscales.

Statistical analysis

Continuous variables were summarized as mean $\pm$ standard deviation and categorical variables as frequency and percentage. Pearson correlation quantified the relationship between HESI and the 20-item depressive symptom burden score overall and within each professional year. Robust multivariable linear

regression with HC3 standard errors was used for the main adjusted analyses. The demographic, academic, lifestyle and psychosocial variables included in these models are shown in Table 4; continuous predictors marked 'per SD' were standardized before analysis. These models were interpreted as adjusted associations rather than causal effects. Effect modification by professional year was assessed by adding HESI×professional-year interaction terms and testing them jointly with a robust Wald test. Factor scores from the exploratory HESI solution were entered simultaneously into an adjusted model to estimate their independent relationships with depressive symptom burden. Two-sided $P < 0.05$ was considered statistically significant. Analyses were conducted from the participant-level dataset.

Exploratory nonlinear prediction

To determine whether nonlinear modelling added predictive information, three deliberately compact multilayer perceptron (MLP) architectures were compared with ridge regression. Professional year was one-hot encoded; continuous predictors were standardized. Model selection used repeated five-fold cross-validation. The selected MLP was then evaluated using out-of-fold predictions, and predictor importance was assessed by permutation within held-out folds. This analysis was prespecified as exploratory and predictive rather than inferential; it was not used to replace the regression estimates.

Ethical considerations

The study was approved by the Institutional Ethics Committee of the study institution (IEC No. 51/22). The research was conducted in accordance with the Declaration of Helsinki and applicable institutional ethical guidelines. Participation was voluntary, and written informed consent was obtained from each participant after explaining the nature and purpose of the study. The analytical dataset used for this report contained no direct personal identifiers.

Results

Participant characteristics

The 466 participants had a mean age of 21.6 ± 1.6 years; 278 (59.7%) were male and 188 (40.3%) female. First-, second-, third- and final-year students constituted 26.4%, 26.8%, 31.5% and 15.2% of the sample, respectively. Two-thirds (66.7%) reported an urban permanent residence and 87.8% were currently living in the college hostel. Thirty-two students (6.9%) reported a chronic illness. Adequate sleep was reported by 52.1%, whereas 27.9% reported having enough leisure time (Table 1).

Table 1
Participant characteristics and principal study measures (N = 466)

Characteristic	Category / summary	Value
Age (years)	Mean $\pm$ SD	21.6 $\pm$ 1.6
Sex	Male	278 (59.7)
	Female	188 (40.3)
Professional year	First	123 (26.4)
	Second	125 (26.8)
	Third	147 (31.5)
	Final	71 (15.2)
Permanent residence	Urban	311 (66.7)
	Rural	155 (33.3)
Current residence	College hostel	409 (87.8)
	Home with parents/relatives	36 (7.7)
	Personal flat/room	21 (4.5)
Chronic illness	Yes	32 (6.9)
Adequate sleep (self-reported)	Yes	243 (52.1)
Enough leisure time	Yes	130 (27.9)
Educational stress (HESI)	Mean $\pm$ SD	56.0 $\pm$ 11.8
Depressive symptom burden	20 universally completed BDI-II items, mean $\pm$ SD	16.7 $\pm$ 11.0
Complete 21-item BDI-II	Complete cases	307 (65.9%)
BDI-II severity (complete cases)	Minimal	131 (42.7)
	Mild	65 (21.2)
	Moderate	65 (21.2)
	Severe	46 (15.0)
Suicidal thoughts/wishes	Any response > 0	80 (17.2)

Educational stress and depressive symptom burden

Mean HESI score was 56.0 $\pm$ 11.8, with good internal consistency (Cronbach α = 0.821). Mean BDI-20 score was 16.7 $\pm$ 11.0. Among the 307 participants with complete 21-item BDI-II data, 42.7% were in the

minimal, 21.2% mild, 21.2% moderate and 15.0% severe symptom category. Eighty of the 466 students (17.2%) endorsed suicidal thoughts or wishes.

Association across professional years

HESI and the 20-item depressive symptom burden score were positively correlated overall ($r = 0.316$, $P < 0.001$). The corresponding correlations were $r = 0.437$ ($P < 0.001$) in first year, $r = 0.167$ ($P = 0.063$) in second year, $r = 0.230$ ($P = 0.005$) in third year and $r = 0.472$ ($P < 0.001$) in final year. In the adjusted model, the HESI $\times$ professional-year terms were jointly significant (Wald $\chi^2=10.43$, $df = 3$, $P = 0.015$), providing evidence that the association differed across professional years. The adjusted change in the 20-item depressive symptom burden score per 1-SD higher HESI was 2.72 points in first year (95% CI 0.91–4.52), 0.11 in second year (95% CI – 1.63 to 1.86), 0.32 in third year (95% CI – 1.87 to 2.51) and 4.23 in final year (95% CI 1.70–6.75) (Table 2; Fig. 1).

Table 2
Association between educational stress and depressive symptom burden overall and across professional years

Analysis	N	Estimate	95% CI	P value
Overall Pearson correlation: HESI vs BDI-20	466	$r = 0.316$	—	< 0.001
Pearson correlation: professional year 1	123	$r = 0.437$	—	< 0.001
Pearson correlation: professional year 2	125	$r = 0.167$	—	0.063
Pearson correlation: professional year 3	147	$r = 0.230$	—	0.005
Pearson correlation: professional year 4	71	$r = 0.472$	—	< 0.001
Adjusted BDI-20 change per 1-SD higher HESI: year 1	123	2.72	0.91 to 4.52	0.003
Adjusted BDI-20 change per 1-SD higher HESI: year 2	125	0.11	-1.63 to 1.86	0.898
Adjusted BDI-20 change per 1-SD higher HESI: year 3	147	0.32	-1.87 to 2.51	0.773
Adjusted BDI-20 change per 1-SD higher HESI: year 4	71	4.23	1.70 to 6.75	0.001
Joint HESI $\times$ professional-year interaction	466	Wald $\chi^2 = 10.43$	$df = 3$	0.015

Dimensions of educational stress

The HESI correlation matrix was suitable for factor analysis (KMO = 0.923; Bartlett $\chi^2_{528}=6335.61$, $P < 0.001$). Parallel analysis supported retention of three factors. The resulting dimensions were interpreted as: demanding/impersonal learning environment; poor educational support/professional fulfilment; and

future/financial/professional concerns. Internal consistency of item sets loading at ≥ 0.40 was 0.897, 0.862 and 0.779, respectively. In the mutually adjusted model, poor educational support/professional fulfilment was associated with higher depressive symptom burden (standardized $\beta = 0.190$, 95% CI 0.094–0.287, $P < 0.001$), as were future/financial/professional concerns ($\beta = 0.094$, 95% CI 0.006–0.182, $P = 0.036$). The demanding/impersonal learning-environment dimension was not independently associated ($\beta = 0.051$, 95% CI – 0.041 to 0.143, $P = 0.280$) (Table 3).

Table 3

Exploratory factor structure of HESI and associations of empirical dimensions with depressive symptom burden

Factor	Representative high-loading items (absolute loading)	Items ≥ 0.40	Cronbach α	Adjusted β with BDI-20 (95% CI)	P value
Demanding/impersonal learning environment	Passive learning (0.73); Future workload worry (0.63); Unclear student role (0.63); Weakness not accepted (0.61); Unclear group activities (0.59)	15	0.897	0.051 (-0.041 to 0.143)	0.280
Poor educational support/professional fulfilment	Training not preparing well (0.75); Low sense of community (0.69); Low teacher encouragement (0.64); Low professional pride (0.64); Low personal development (0.63)	10	0.862	0.190 (0.094 to 0.287)	< 0.001
Future/financial/professional concerns	Presentation worry (0.56); Family career pressure (0.52); Financial worry (0.49); Accommodation worry (0.48); Future financial worry (0.44)	6	0.779	0.094 (0.006 to 0.182)	0.036

Shared and distinct correlates

In the adjusted depressive-symptom model, greater life satisfaction was inversely associated with BDI-20 (standardized $\beta = -0.329$, $P < 0.001$). Loneliness ($\beta = 0.160$, $P < 0.001$), social-media use ($\beta = 0.157$, $P = 0.001$) and educational stress ($\beta = 0.142$, $P = 0.004$) were positively associated, while adequate sleep was inversely associated ($\beta = -0.277$, $P = 0.002$). The model explained 30.7% of the variance. In the educational-stress model, academic strain had the largest positive standardized association ($\beta = 0.345$, $P < 0.001$), followed by loneliness ($\beta = 0.116$, $P = 0.010$), hostel adversity ($\beta = 0.111$, $P = 0.021$) and social-

media use ($\beta = 0.106$, $P = 0.018$); life satisfaction was inversely associated ($\beta = -0.092$, $P = 0.029$). This model explained 30.0% of the variance (Table 4; Fig. 2).

Exploratory nonlinear prediction

Among the compact neural-network models, the 8–4 hidden-neuron MLP had the best repeated cross-validated performance, but it remained inferior to the ridge-regression benchmark. Mean fold R^2 was 0.178 for the selected MLP compared with 0.265 for ridge regression. In a fixed five-fold out-of-fold evaluation, the MLP achieved $R^2=0.104$, mean absolute error = 7.60 and root mean squared error = 10.44. Thus, the additional nonlinear complexity did not improve generalization in this dataset (Fig. 3).

Discussion

Educational stress was positively associated with depressive symptom burden, with evidence that the strength of this association differed across professional years. Larger estimated associations were observed in first and final year than in the middle professional years. The factor analysis also indicated that educational stress was not a single construct: poor educational support/professional fulfilment and future/financial/professional concerns were associated with depressive symptom burden after adjustment, whereas the demanding/impersonal learning-environment dimension was not.

The study included students from all professional years, used proportionate stratified random sampling and applied validated instruments for depressive symptoms and educational stress. Its cross-sectional design does not establish temporal relationships, and the single-institution setting limits wider generalizability. The HESI factor structure was exploratory and requires confirmation in an independent sample. Missing responses to the optional BDI-II sexual-interest item were handled conservatively by restricting continuous analyses to the 20 universally completed items rather than imputing absence of the symptom.

The burden of depressive symptoms among Indian medical students has been documented consistently. Dutta et al. reported a pooled prevalence of depression of about 50% among Indian undergraduate medical students,¹ while a more recent meta-analysis also reported substantial levels of anxiety, stress and suicidal ideation.² The present findings add to this evidence by examining educational stress as a multidimensional exposure and by assessing variation in its relationship with depressive symptoms across professional years.

The professional-year-specific pattern is consistent with earlier HESI work. In the original study by Dahlin et al., the profile of educational stressors differed across years of medical education, with workload and feedback prominent early and concerns about future endurance, competence and educational climate becoming more salient later.⁴ Garg et al., studying North Indian medical students, similarly found financial concerns to be prominent in first year, faculty shortcomings and insufficient feedback in second year, and future endurance and competence in final year.⁶ Saxena et al. also reported positive

relationships between educational stress and depression and anxiety among Indian professional undergraduates.⁷ The present analysis extends these observations by testing the interaction directly: professional year modified the association between total educational stress and continuous depressive symptom burden rather than merely showing different mean stress scores between batches.

The stronger association in first year is plausible in the context of transition. Entry into medical college brings a rapid change in academic expectations, peer networks and, for many students, living arrangements. At the other end of the undergraduate course, final-year students encounter greater clinical responsibility, high-stakes examinations and more immediate concerns about competence and professional life. Recent qualitative and quantitative work from India has again highlighted academic demands, social isolation, reduced recreation and difficult transitions within medical training.⁸ These explanations, however, remain interpretations rather than causal findings. Because each professional year in the present study represents a different cohort observed at one point in time, stage effects cannot be separated completely from cohort effects without longitudinal follow-up.

HESI was developed as a multidimensional measure, and validation studies have identified domains related to teacher–student relationships, educational climate, workload, financial concerns and worries about the future profession.⁵ In the present sample, parallel analysis supported a three-factor structure. The dimension reflecting poor educational support and professional fulfilment had the strongest independent association with depressive symptoms, followed by future, financial and professional concerns. This pattern suggests that students' experience of support, feedback and professional development may be relevant alongside academic workload. As these dimensions were derived from the present sample, they should be confirmed in other student populations before being used as separate subscales. Longitudinal evidence from medical students has also linked less supportive educational climates and lower belongingness with subsequent mental ill-health symptoms.¹⁴

The shared-correlate models reinforce that interpretation. Loneliness, lower life satisfaction and greater social-media use were associated with both educational stress and depressive symptoms, whereas academic strain and hostel adversity were more closely related to educational stress. Adequate sleep was independently associated with lower depressive symptom burden. The inverse coefficient observed for weekly/daily substance use in the depressive-symptom model should not be interpreted as a protective association; given the cross-sectional design and the distribution of this exposure, it is best regarded as an unstable adjusted estimate requiring replication. Murugan et al. recently reported substantial stress and social isolation among Indian medical students and described academics, limited recreation and transition to clinical training as recurring concerns.⁸ The convergence with the present findings is notable, but directionality remains uncertain. For example, loneliness may increase vulnerability to educational stress, while depressive symptoms may themselves reduce social engagement; similarly, heavy social-media use may be a coping response rather than an antecedent exposure. A recent prospective study from India also demonstrated that psychological distress can change during the first year of medical training, supporting attention to professional-year-specific

student experience¹⁵. Related evidence from nursing students in North India has also documented stress and associated social and behavioural conditions in another health-professional student population¹⁶.

The missing optional BDI-II sexual-interest item was not scored as zero; continuous analyses therefore used the 20 items completed by all participants, while conventional 21-item severity categories were restricted to complete responders.

In the exploratory predictive analysis, the 8–4 MLP showed lower cross-validated performance than ridge regression (mean fold R^2 0.18 versus 0.27). Thus, the nonlinear model did not improve prediction in this dataset. The neural-network analysis was retained as an exploratory supplementary assessment, while the regression models remained the main basis for interpretation.

The variation across professional years identifies areas that merit prospective evaluation. Mentoring and faculty feedback may be particularly relevant to examine during entry into medical college and the final professional year, while sleep, social connectedness and access to confidential mental-health support remain relevant throughout medical education. Prospective studies can clarify whether changes in educational stress are followed by changes in depressive symptoms and whether professional-year-specific educational support improves student well-being.

Conclusions

Educational stress was associated with depressive symptom burden, with evidence that the strength and nature of this relationship differed across professional years. Educational support, professional fulfilment and future-oriented concerns emerged as particularly relevant dimensions. Longitudinal studies are needed to determine whether these relationships are temporal and whether professional-year-specific educational support can improve student well-being.

Declarations

Ethics approval and consent to participate

The study was approved by the Institutional Ethics Committee, Dr Ram Manohar Lohia Institute of Medical Sciences (Dr RMLIMS), Lucknow (IEC No. 51/22). The proposal was considered at the Institutional Ethics Committee meeting on 21 July 2022, and the approval letter was issued on 1 August 2022. The research was conducted in accordance with the Declaration of Helsinki and applicable institutional ethical guidelines. Participation was voluntary, and written informed consent was obtained from each participant after explaining the nature and purpose of the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Author Contribution

A.T., C.S., B.S., A.S. and V.S. contributed substantially to the conception and design of the study, data collection, analysis and interpretation of the findings. All authors contributed to drafting the manuscript and/or critically revising it for important intellectual content. All authors reviewed and approved the final manuscript and agreed to be accountable for all aspects of the work.

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Availability of data and materials

De-identified data may be made available by the corresponding author subject to institutional and ethical requirements.

Table 4

Table 4

Multivariable analysis of shared and distinct correlates of depressive symptom burden and educational stress

Variable	Depressive symptom burden β (95% CI)	P value	Educational stress β (95% CI)	P value
Female sex	-0.035 (-0.198 to 0.127)	0.671	-0.198 (-0.357 to -0.039)	0.015
Age (per SD)	-0.033 (-0.121 to 0.056)	0.471	0.045 (-0.057 to 0.147)	0.390
Second professional year	-0.089 (-0.302 to 0.124)	0.413	0.084 (-0.143 to 0.311)	0.470
Third professional year	-0.045 (-0.291 to 0.201)	0.717	0.144 (-0.092 to 0.381)	0.232
Final professional year	-0.004 (-0.313 to 0.306)	0.981	0.059 (-0.250 to 0.367)	0.709
Chronic illness	0.250 (-0.108 to 0.608)	0.170	0.156 (-0.183 to 0.494)	0.367
Life satisfaction (per SD)	-0.329 (-0.433 to -0.225)	< 0.001	-0.092 (-0.175 to -0.009)	0.029
Loneliness (per SD)	0.160 (0.066 to 0.254)	< 0.001	0.116 (0.027 to 0.204)	0.010
Adequate sleep	-0.277 (-0.449 to -0.105)	0.002	-0.120 (-0.291 to 0.052)	0.172
Adequate leisure time	-0.005 (-0.182 to 0.173)	0.958	-0.068 (-0.265 to 0.128)	0.495
Social-media use/addiction (per SD)	0.157 (0.063 to 0.251)	0.001	0.106 (0.018 to 0.194)	0.018
Weekly/daily substance use	-0.476 (-0.935 to -0.018)	0.042	-0.247 (-0.632 to 0.139)	0.209
Educational stress (HESI, per SD)	0.142 (0.046 to 0.238)	0.004	—	—
Academic strain (per SD)	—	—	0.345 (0.243 to 0.448)	< 0.001
Hostel adversity (per SD)	—	—	0.111 (0.017 to 0.206)	0.021
Adjusted R ²	0.307	—	0.300	—

Note: Outcomes are standardized BDI-20 depressive symptom burden and standardized HESI total scores. Continuous predictors labelled 'per SD' were standardized; binary variables were entered as indicator variables; first professional year was the reference category. β values are adjusted regression coefficients; 95% CIs are based on HC3 robust standard errors.

Variable	Depressive symptom burden β (95% CI)	P value	Educational stress β (95% CI)	P value
Outcome	BDI-20 standardized score	—	HESI standardized score	—
Note: Outcomes are standardized BDI-20 depressive symptom burden and standardized HESI total scores. Continuous predictors labelled 'per SD' were standardized; binary variables were entered as indicator variables; first professional year was the reference category. β values are adjusted regression coefficients; 95% CIs are based on HC3 robust standard errors.				

References

1. Dutta G, Rajendran N, Kumar T, Varthya SB, Rajendran V. Prevalence of depression among undergraduate medical students in India: a systematic review and meta-analysis. *Cureus*. 2023;15(1):e33590. 10.7759/cureus.33590.
2. Kaur H, Gupta V, Garg A, Sangeeta, Padhi BK. Prevalence of depression, anxiety, stress and suicide ideation among undergraduate medical students in India: a systematic review and meta-analysis. *Natl J Community Med*. 2024;15(10):868–83. 10.55489/njcm.151020244529.
3. Agyapong-Opoku N, Agyapong-Opoku F, Agyapong B, Greenshaw AJ. Anxiety and depressive symptoms among medical students—a scoping review of systematic reviews and meta-analyses. *Front Public Health*. 2026;13:1710333. 10.3389/fpubh.2025.1710333.
4. Dahlin M, Joneborg N, Runeson B. Stress and depression among medical students: a cross-sectional study. *Med Educ*. 2005;39(6):594–604. 10.1111/j.1365-2929.2005.02176.x.
5. Shim EJ, Jeon HJ, Kim H, Lee KM, Jung D, Noh HL, et al. Measuring stress in medical education: validation of the Korean version of the Higher Education Stress Inventory with medical students. *BMC Med Educ*. 2016;16:302. 10.1186/s12909-016-0824-9.
6. Garg K, Agarwal M, Dalal PK. Stress among medical students: a cross-sectional study from a North Indian Medical University. *Indian J Psychiatry*. 2017;59(4):502–4. 10.4103/psychiatry.IndianJPsychiatry_239_17.
7. Saxena SK, Mani RN, Dwivedi AK, Ryali VSSR, Timothy A. Association of educational stress with depression, anxiety, and substance use among medical and engineering undergraduates in India. *Ind Psychiatry J*. 2019;28(2):160–9. 10.4103/ipj.ipj_3_20.
8. Murugan Y, Dave A, Patel S, Ram R. Fostering wellness in medical education: a mixed method study of stress, isolation, and coping among undergraduate students in India. *Indian J Community Med*. 2025;50(3):453–7. 10.4103/ijcm.ijcm_776_23.
9. Goel A, Sethi Y, Moinuddin A, Deepak D, Gupta P. Competency-based medical education curriculum and its effect on prevalence of anxiety, depression and stress amongst medical undergraduates. *J Educ Health Promot*. 2022;11:380. 10.4103/jehp.jehp_564_22.
10. Singh C, Singh A, Saini A. Unseen struggles in the white coat: predictors of stress among postgraduate medical students in India. *Int J Community Med Public Health*. 2026;13(8):4267–72.

10.18203/2394-6040.ijcmph20262701.

11. Kumar GS, Jain A, Hegde S. Prevalence of depression and its associated factors using Beck Depression Inventory among students of a medical college in Karnataka. *Indian J Psychiatry*. 2012;54(3):223–6. 10.4103/0019-5545.102412.
12. Beck AT, Steer RA, Brown GK. *Manual for the Beck Depression Inventory-II*. San Antonio (TX): Psychological Corporation; 1996.
13. Hayton JC, Allen DG, Scarpello V. Factor retention decisions in exploratory factor analysis: a tutorial on parallel analysis. *Organ Res Methods*. 2004;7(2):191–205. 10.1177/1094428104263675.
14. Medisauskaite A, Silkens MEWM, Rich A. A national longitudinal cohort study of factors contributing to UK medical students' mental ill-health symptoms. *Gen Psychiatr*. 2023;36(2):e101004. 10.1136/gpsych-2022-101004.
15. Mallaram GK, Gopalakrishnan U, Mathews DA, Mudamala DS, Gangavarappagari H, Modi U, et al. 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*. 2024 Nov;19:02537176241282100. 10.1177/02537176241282100.
16. Singh S, Kunwer R, Pathak P, Singh C. A cross-sectional study of stress and related conditions among nursing students at a tertiary care hospital, North India. *Healthline*. 2025;16(1):51–8. 10.51957/Healthline_702_2025.

Figures

Figure 1. Educational stress and depressive symptom burden by professional year

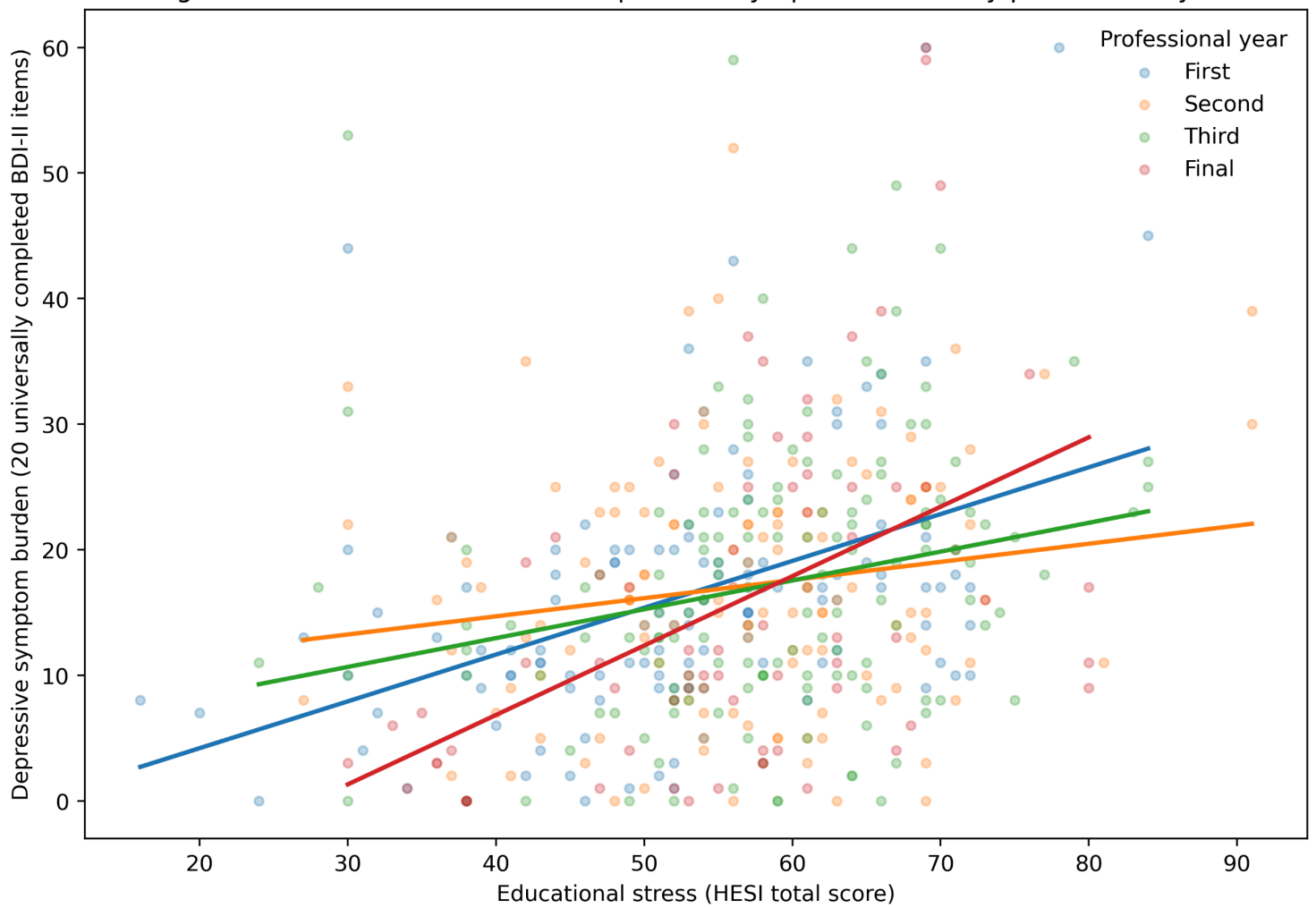


Figure 1

Educational stress and depressive symptom burden across professional years. Lines show the observed relationship within each professional year.

Figure 2. Shared and distinct adjusted correlates of the two outcomes

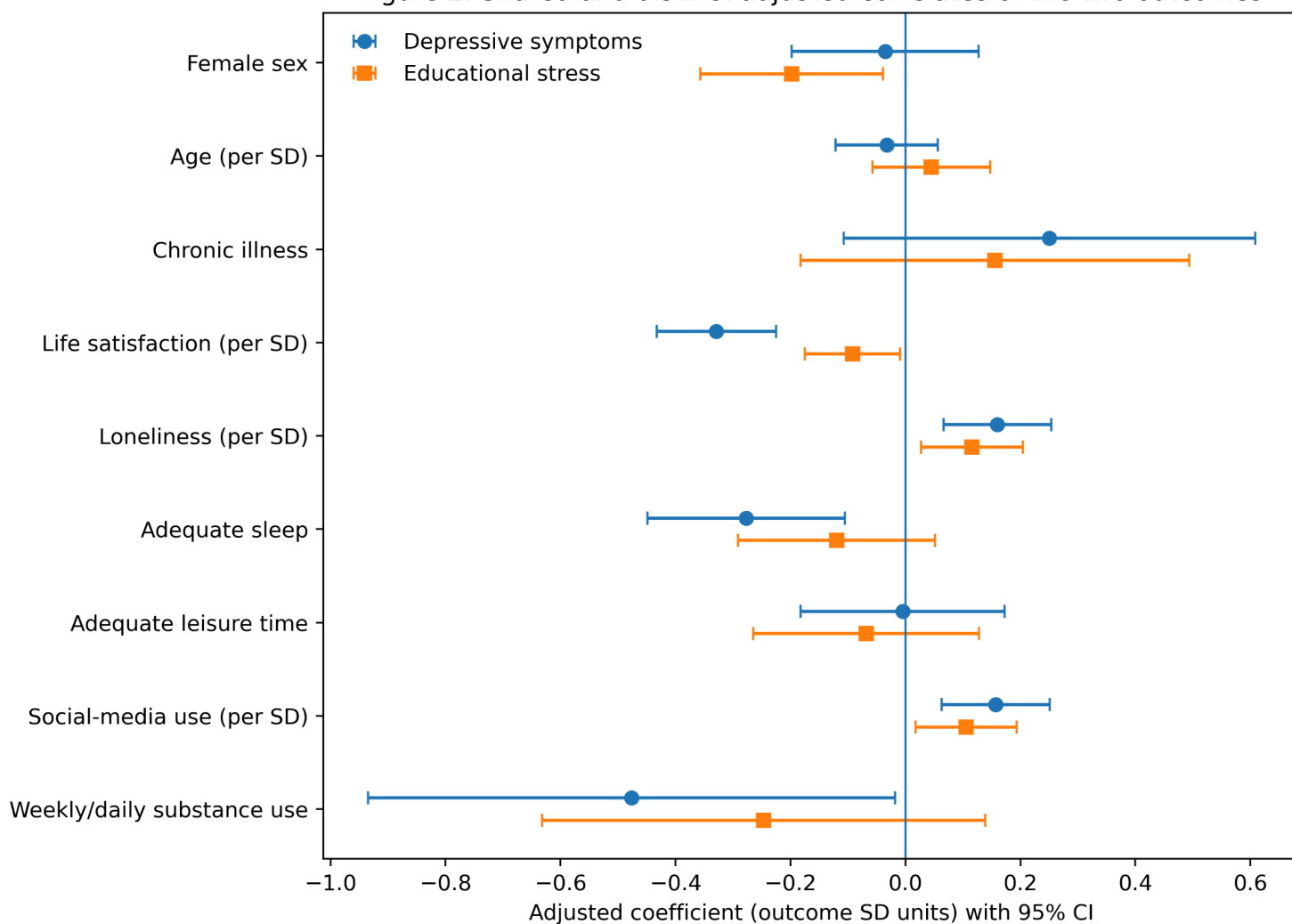
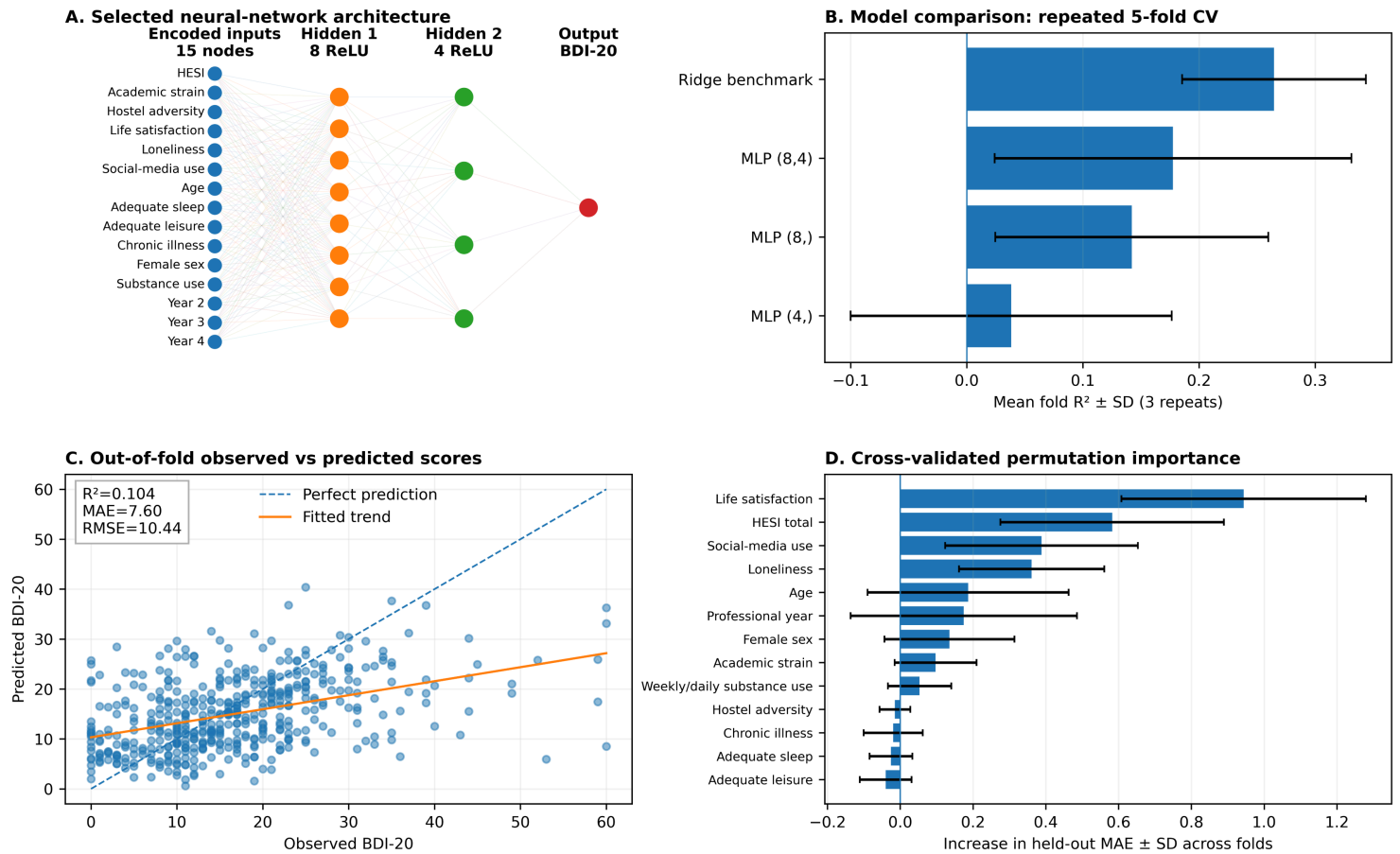


Figure 2

Shared and distinct adjusted correlates of depressive symptom burden and educational stress. Points represent adjusted coefficients with 95% confidence intervals.

Figure 3. Exploratory validated neural-network analysis of depressive symptom burden



N=466. Professional year was one-hot encoded. Best compact MLP: (8, 4). Architecture chosen from prespecified compact models using repeated 5-fold CV; ridge regression is the linear benchmark.

Figure 3

Exploratory validated neural-network analysis of depressive symptom burden. The figure shows the selected compact MLP architecture, repeated cross-validation comparison with ridge regression, out-of-fold predictions and cross-validated permutation importance.