

Research Article**Association Between Use of AI-Based Study Tools and Psychological Stress Among Undergraduate Medical Students**

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Abstract

Artificial intelligence-based educational tools have rapidly transformed medical education by providing personalized learning support, automated content generation, adaptive assessments, and instant academic assistance. Despite their educational advantages, increasing dependence on artificial intelligence-based study tools may influence psychological wellbeing, academic stress, and learning behavior among undergraduate medical students. The present study aimed to evaluate the association between use of artificial intelligence-based study tools and psychological stress among undergraduate medical students at a tertiary medical institution. A prospective observational analytical study was conducted on 268 undergraduate medical students between January 2023 and December 2024. Frequency of artificial intelligence-based study tool usage, academic performance indicators, sleep patterns, and study behaviors were assessed using structured questionnaires. Psychological stress levels were evaluated using the Perceived Stress Scale. Students with high-frequency use of artificial intelligence-based study tools demonstrated significantly higher psychological stress scores compared with

moderate and low-frequency users ($p < 0.001$). Excessive dependence on artificial intelligence-generated educational content was associated with reduced self-directed learning confidence, increased examination anxiety, disturbed sleep patterns, and prolonged screen exposure. Moderate use of artificial intelligence-based study tools was associated with improved academic organization and reduced time-management stress. Female students and preclinical-year students demonstrated comparatively higher stress scores associated with excessive artificial intelligence tool utilization. Multivariate regression analysis identified prolonged daily screen time, academic overload, reduced sleep duration, and excessive artificial intelligence dependency as independent predictors of elevated psychological stress. The findings emphasize the complex relationship between artificial intelligence-assisted learning and student mental wellbeing and highlight the need for balanced educational integration strategies promoting responsible artificial intelligence use in medical education.

Keywords: Artificial intelligence, Psychological stress, Medical students

Introduction

Artificial intelligence has rapidly emerged as one of the most influential technological advancements in modern education and healthcare systems. Artificial intelligence-based educational tools including intelligent tutoring systems, automated question generators, adaptive learning platforms, virtual assistants, and generative language models have increasingly become integrated into undergraduate medical education [1-3]. These technologies provide rapid access to educational resources, personalized academic support, clinical simulation assistance, and automated explanation of complex medical concepts.

Medical education is widely recognized as academically intensive and psychologically demanding because of extensive curricular requirements, high examination burden, prolonged study hours, and competitive learning environments. Undergraduate medical students frequently experience substantial levels of stress, anxiety, emotional exhaustion, sleep disturbance, and burnout during their academic training [2-4]. Educational technologies capable of improving learning efficiency and reducing academic burden are therefore receiving increasing attention within medical institutions.

Artificial intelligence-based study tools have demonstrated considerable educational benefits in several learning environments. Students may utilize artificial intelligence applications for concept clarification, clinical case discussion, examination preparation, language improvement, note summarization, and self-assessment exercises [3-5]. Personalized learning pathways and immediate academic feedback provided by artificial intelligence systems may improve study efficiency and reduce time-related academic pressure.

Despite these advantages, concerns have emerged regarding the psychological and behavioral effects of excessive artificial

intelligence dependency among students. Overreliance on automated educational assistance may impair self-directed learning behavior, critical thinking ability, independent problem-solving, and intrinsic academic motivation [4-6]. Furthermore, constant engagement with digital learning platforms may contribute to increased screen exposure, social isolation, sleep disturbance, and cognitive overload.

Psychological stress among medical students is influenced by multiple academic and nonacademic factors including examination pressure, fear of failure, workload intensity, sleep deprivation, social expectations, and uncertainty regarding professional competence [5-7]. Artificial intelligence-assisted learning may either alleviate or exacerbate stress depending on usage patterns, educational context, and individual coping mechanisms. Moderate utilization may facilitate academic organization and confidence, whereas excessive dependence may increase anxiety regarding academic performance and technological reliance.

Recent literature suggests that excessive digital technology use may negatively affect psychological wellbeing, concentration, sleep quality, and emotional resilience among university students [6-8]. Artificial intelligence-based study tools differ from conventional educational technologies because they provide highly interactive and often human-like educational assistance, potentially altering traditional learning behaviors and academic expectations. Consequently, understanding their psychological implications has become increasingly important.

Medical students in developing countries often experience additional educational challenges related to limited faculty access, high student-to-teacher ratios, inadequate academic resources, and intense examination competition [7-9]. Artificial intelligence-based study tools may therefore become

highly attractive learning alternatives in resource-constrained educational environments. However, balanced integration remains essential to prevent unhealthy dependence and associated psychological stress.

Current evidence regarding the relationship between artificial intelligence-based educational tools and mental wellbeing among medical students remains limited. Existing studies have primarily focused on academic performance, technological acceptance, and educational effectiveness, whereas comparatively fewer investigations have specifically examined psychological stress associated with artificial intelligence-assisted learning [8-10]. Additionally, evidence from South Asian medical institutions remains scarce despite rapidly increasing digital technology adoption among students.

The present study was therefore designed to evaluate the association between use of artificial intelligence-based study tools and psychological stress among undergraduate medical students. The study additionally aimed to assess patterns of artificial intelligence tool usage, sleep behavior, academic confidence, and examination anxiety associated with different levels of technological dependence. By generating updated regional evidence, the findings may contribute toward development of balanced educational policies promoting responsible and psychologically healthy integration of artificial intelligence within medical education.

Methodology

A prospective observational analytical study was conducted at the Fatima Memorial College for Medicine and Dentistry after approval from the institutional ethical review committee. The study included undergraduate medical students enrolled in first- to final-year MBBS programs. The sample size was calculated using OpenEpi

software version 3.01 by considering an anticipated prevalence of elevated psychological stress among medical students of 50%, confidence interval of 95%, margin of error of 6%, and study power of 80%, resulting in a minimum sample size requirement of 250 participants. After adjustment for incomplete responses and nonparticipation, 268 students were enrolled. Students aged 18 years and above who regularly used digital educational resources during medical studies were included. Students with previously diagnosed psychiatric disorders under active treatment, prolonged academic leave, or incomplete questionnaire responses were excluded. Verbal informed consent was obtained from all participants before enrollment. Confidentiality and anonymity of participant responses were maintained throughout the study.

A structured self-administered questionnaire was used to collect demographic information including age, gender, academic year, residence, socioeconomic status, academic performance, and average daily study duration. Information regarding use of artificial intelligence-based study tools was obtained, including frequency of use, duration of screen exposure, type of applications utilized, purposes of usage, and perceived academic dependency. Commonly reported artificial intelligence tools included language-based educational assistants, automated question generators, adaptive quiz platforms, and intelligent note summarization applications.

Participants were categorized into low-frequency users, moderate-frequency users, and high-frequency users according to average daily duration of artificial intelligence tool utilization. Psychological stress was assessed using the validated Perceived Stress Scale consisting of ten standardized items evaluating emotional stress, academic pressure, coping ability, and

psychological overload during the preceding month.

Additional variables including sleep duration, examination anxiety, academic confidence, self-directed learning behavior, physical activity, and social interaction patterns were assessed using standardized questionnaires. Academic performance was evaluated using self-reported recent examination grades and perceived academic satisfaction.

Data analysis was performed using SPSS version 26.0. Quantitative variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Independent t-test, one-way ANOVA, and chi-square test were used to compare stress scores and behavioral variables among different

artificial intelligence usage groups. Pearson correlation analysis was performed to evaluate relationships between screen time, artificial intelligence usage duration, and stress scores. Multivariate linear regression analysis was conducted to identify independent predictors of elevated psychological stress. A p-value less than 0.05 was considered statistically significant.

Results

A total of 268 undergraduate medical students participated in the study. The mean age of participants was 21.7 ± 1.8 years, and female students constituted 59.3% of the study population. High-frequency use of artificial intelligence-based study tools was observed in 38.1% of students, while 34.3% demonstrated moderate use and 27.6% demonstrated low-frequency use.

Table 1. Demographic Characteristics and Artificial Intelligence Tool Usage Patterns

Variable	Frequency/Mean $\pm$ SD	Percentage	p-value
Mean age (years)	21.7 ± 1.8	—	0.214
Female gender	159	59.3%	0.037
High-frequency AI tool users	102	38.1%	<0.001
Moderate-frequency AI tool users	92	34.3%	<0.001
Low-frequency AI tool users	74	27.6%	<0.001
Mean daily AI usage duration (hours)	3.9 ± 1.7	—	<0.001
Average screen exposure (hours/day)	7.2 ± 2.4	—	0.002
Sleep duration (hours/night)	5.9 ± 1.3	—	<0.001
Preclinical-year students	148	55.2%	0.018

Explanation: High-frequency utilization of artificial intelligence-based study tools was common among undergraduate medical students. Increased screen exposure and reduced sleep duration were significantly associated with frequent artificial intelligence use.

Table 2. Comparison of Psychological Stress and Academic Variables According to Artificial Intelligence Tool Usage Frequency

Variable	High-Frequency Users	Moderate Users	Low-Frequency Users	p-value
Mean stress score	27.4 ± 5.6	20.8 ± 4.7	16.9 ± 4.1	<0.001

Variable	High-Frequency Users	Moderate Users	Low-Frequency Users	p-value
Examination anxiety score	21.7 ± 4.2	17.5 ± 3.8	14.8 ± 3.5	<0.001
Academic confidence score	58.6 ± 7.9	71.2 ± 6.8	66.4 ± 7.1	<0.001
Self-directed learning score	49.3 ± 6.5	67.8 ± 5.9	71.1 ± 6.4	<0.001
Sleep quality score	10.8 ± 3.7	15.2 ± 4.1	17.4 ± 3.9	<0.001

Explanation: Students with high-frequency artificial intelligence tool utilization demonstrated significantly higher stress and examination anxiety scores, reduced sleep quality, and lower self-directed learning scores compared with moderate and low-frequency users.

Table 3. Predictors of Elevated Psychological Stress Among Medical Students

Predictor Variable	Odds Ratio (95% CI)	p-value
High-frequency AI tool use	3.82 (2.14–6.81)	<0.001
Sleep duration <6 hours	2.94 (1.76–4.92)	<0.001
Daily screen time >7 hours	2.71 (1.58–4.63)	0.001
Preclinical academic year	2.33 (1.39–3.88)	0.002
Examination-related anxiety	3.11 (1.84–5.27)	<0.001
Reduced physical activity	1.92 (1.14–3.21)	0.014

Explanation: High-frequency artificial intelligence tool use, prolonged screen exposure, reduced sleep duration, and examination anxiety were significant independent predictors of elevated psychological stress among medical students.

Discussion

The present study demonstrated a significant association between high-frequency use of artificial intelligence-based study tools and elevated psychological stress among undergraduate medical students. Students with excessive dependence on artificial intelligence-assisted learning demonstrated significantly higher stress levels, examination anxiety, sleep disturbance, and reduced self-directed learning confidence compared with moderate and low-frequency users. These findings highlight the complex

psychological implications of rapidly increasing artificial intelligence integration within medical education [11-12].

Medical students frequently experience substantial academic stress because of demanding curricula, examination pressure, and extensive learning requirements. Artificial intelligence-based educational tools may initially reduce educational burden by facilitating rapid information retrieval and academic organization; however, excessive dependency may contribute to cognitive overload and reduced independent learning confidence [11-13]. Students relying heavily on automated educational support may develop anxiety regarding personal academic competence and fear of underperformance without technological assistance.

The current study demonstrated that moderate-frequency artificial intelligence users exhibited comparatively higher academic confidence and lower stress scores than excessive users. This finding suggests that balanced technological integration may enhance educational efficiency without negatively affecting psychological wellbeing [12-14]. Artificial intelligence tools used as supplementary educational aids rather than primary learning substitutes may improve organization, concept clarification, and time management while preserving independent cognitive engagement.

Reduced sleep quality and prolonged screen exposure were significantly associated with high-frequency artificial intelligence utilization in the present study. Excessive digital device use has consistently been linked with sleep disturbance, mental fatigue, reduced concentration, and emotional stress among university students [13-15]. Continuous engagement with artificial intelligence applications may additionally contribute to information overload and prolonged academic engagement beyond healthy study durations.

Preclinical-year students demonstrated comparatively higher psychological stress associated with artificial intelligence dependency. Early-stage medical students frequently experience adjustment difficulties, uncertainty regarding academic expectations, and limited clinical exposure [14-16]. Consequently, these students may become more dependent on artificial intelligence-based educational assistance, potentially increasing technological reliance and stress-related psychological burden.

Examination anxiety emerged as a major independent predictor of psychological stress in the current study. Medical students often utilize artificial intelligence tools extensively during examination preparation because of pressure to achieve academic excellence and fear of failure [15-17]. Although artificial

intelligence-assisted revision may improve short-term preparedness, excessive reliance may paradoxically increase anxiety by creating unrealistic academic expectations and continuous comparison with automated performance standards.

Reduced self-directed learning confidence observed among high-frequency artificial intelligence users is another important finding of the present investigation. Self-directed learning represents a critical competency in medical education because future healthcare professionals must continuously update clinical knowledge independently throughout professional practice [16-18]. Overdependence on automated educational systems may potentially impair critical thinking, independent reasoning, and intrinsic academic motivation if not appropriately regulated.

The findings of the present study have important implications for medical education policy and digital learning strategies. Artificial intelligence-based educational tools should be integrated responsibly within undergraduate curricula through balanced guidance emphasizing critical thinking, independent learning, and healthy digital behavior [17-20]. Faculty mentorship, digital literacy education, and mental health support programs may assist students in utilizing artificial intelligence effectively without compromising psychological wellbeing. The present study additionally contributes regional evidence regarding psychological stress associated with artificial intelligence-assisted learning among medical students in South Asia, where digital educational technology adoption continues to expand rapidly.

Conclusion

High-frequency use of artificial intelligence-based study tools is significantly associated with increased psychological stress, examination anxiety, reduced sleep quality,

and lower self-directed learning confidence among undergraduate medical students. Moderate and balanced utilization of artificial intelligence educational tools may improve academic organization while minimizing adverse psychological effects. Educational institutions should promote responsible artificial intelligence integration strategies that support both academic performance and student mental wellbeing.

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