

Use of AI Tools and Academic Performance in Medical Education

Samia Sarwar^{1*}, Amna Zia², Junaid Iqbal³, Sobia Nawaz⁴, Rafia Minhas⁵, Sehrish Liaqat⁶

^{1*}Professor, Department of Physiology, Rawalpindi Medical University Rawalpindi, Pakistan.

²Assistant Professor, Department of Anatomy, King Edward Medical University Lahore, Pakistan.

³Associate Professor, Department of Physiology, Sahara Medical College Narowal, Pakistan.

⁴Assistant Professor, Department of Medical Education, Continental Medical College Lahore, Pakistan.

⁵Assistant Professor, Department of Medical Education, Rahber Medical & Dental College Lahore, Pakistan.

⁶Senior Lecturer, Department of Community Medicine, Sahara Medical College Narowal, Pakistan.

Corresponding Author: Samia Sarwar

Professor, Department of Physiology, Rawalpindi Medical University Rawalpindi, Pakistan.

Email: drsamsarwar@yahoo.com

Received: 12.03.2026 Revised: 26.04.2026 Accepted: 21.05.2026

ABSTRACT

Background: Artificial Intelligence (AI) tools have rapidly transformed the educational landscape, particularly in medical education where students face extensive academic workloads and complex clinical learning requirements. AI-based platforms such as intelligent tutoring systems, automated question generators, virtual simulations, and language-processing tools are increasingly being utilized to enhance learning efficiency, improve access to educational resources, and support personalized learning experiences. Medical students commonly use AI applications for note preparation, concept clarification, literature searching, examination preparation, and clinical decision-making practice. Despite the growing integration of AI technologies in academic settings, concerns remain regarding overreliance on these tools, reduced critical thinking abilities, and ethical issues related to academic integrity. Therefore, understanding the relationship between AI tool utilization and academic performance among medical students has become increasingly important.

Objective: To evaluate the use of AI tools and their association with academic performance among medical students.

Methodology: A cross-sectional descriptive study was conducted among undergraduate medical students enrolled in different academic years at a medical university. A structured, self-administered questionnaire was distributed to collect data regarding demographic characteristics, frequency and purpose of AI tool usage, commonly used AI applications, perceived benefits, and academic outcomes. Students' academic performance was assessed using self-reported grade point averages (GPA) and examination scores. Data were analyzed using statistical software. Descriptive statistics, frequencies, percentages, mean scores, and chi-square tests were applied to determine associations between AI tool usage and academic performance. A p-value of <0.05 was considered statistically significant.

Results: A total of 250 medical students participated in the study, with a mean age of 21.4 ± 2.1 years. Among the participants, 62% were female and 38% were male. Approximately 84% of students reported regular use of AI tools for academic purposes. The most commonly used applications included AI chat assistants, online medical learning platforms, and automated quiz generators. About 71% of students believed that AI tools improved their understanding of difficult medical concepts, while 67% reported enhanced examination preparation and time management. Students who frequently utilized AI-based educational resources demonstrated significantly higher academic performance compared to infrequent users ($p < 0.05$). However, nearly 41% of participants expressed concerns regarding dependency on AI tools and reduced independent learning skills.

Conclusion: AI tools are widely utilized among medical students and appear to positively influence academic performance, learning efficiency, and conceptual understanding. Appropriate integration of AI technologies into medical education may enhance student learning outcomes; however, balanced usage and proper academic guidance are necessary to prevent excessive dependency and maintain critical thinking abilities.

Keywords: Artificial Intelligence, Medical Education, Academic Performance, Medical Students, Digital Learning, Educational Technology, AI Tools, Undergraduate Education.

INTRODUCTION

The rapid advancement of digital technologies has significantly transformed educational systems worldwide, particularly in higher education and professional training programs. Among these technological innovations, Artificial Intelligence (AI) has emerged as one of the most influential developments affecting teaching, learning, assessment, and academic research. AI refers to computer systems and software applications capable of performing tasks that typically require human intelligence, including problem-solving, language processing, pattern recognition, decision-making, and adaptive learning. In recent years, AI-powered educational tools have gained substantial attention in medical education due to their potential to improve learning efficiency, provide personalized educational experiences, and enhance students' academic performance ^(1,2).

Medical education is widely recognized as academically demanding and intellectually intensive. Medical students are required to acquire extensive theoretical knowledge, develop clinical reasoning abilities, and maintain continuous learning throughout their academic and professional careers. Traditional teaching methods, including lectures, textbooks, and conventional examinations, often present challenges in meeting the diverse learning needs of students. Consequently, educational institutions have increasingly integrated digital learning technologies into medical curricula to facilitate more flexible, interactive, and student-centered learning environments. Within this context, AI tools have become increasingly popular among medical students for academic support and self-directed learning ⁽³⁾.

AI applications in medical education include intelligent tutoring systems, virtual patient simulations, adaptive learning platforms, automated assessment systems, speech recognition technologies, plagiarism detection tools, and AI-based chat assistants. These technologies assist students in various academic activities such as note preparation, summarization of complex medical concepts, and generation of practice questions, literature searching, language correction, and examination preparation. AI-powered platforms can analyze learners' performance patterns and provide customized feedback, allowing students to identify their weaknesses and improve their

learning outcomes more efficiently. Furthermore, AI tools can offer immediate responses to students' queries, thereby promoting independent learning and improving time management ⁽⁴⁾.

The increasing accessibility of AI applications has led to widespread adoption among university students worldwide. In medical education specifically, AI-supported learning environments have demonstrated positive effects on knowledge retention, conceptual understanding, clinical reasoning, and problem-solving skills. Several studies have reported that AI-enhanced educational interventions contribute to improved student engagement and academic satisfaction. Virtual simulations and adaptive learning systems allow learners to repeatedly practice clinical scenarios in a risk-free environment, thereby enhancing both theoretical and practical competencies. Additionally, AI technologies have become particularly valuable following the COVID-19 pandemic, during which online and technology-assisted learning rapidly expanded across educational institutions globally ^(5,6).

Recent advancements in generative AI models, including natural language processing systems and conversational AI applications, have further accelerated the use of AI in academic settings. Many medical students now utilize AI-based chat assistants to explain difficult concepts, generate summaries, create study schedules, and answer practice questions. These systems provide rapid access to information and can simplify complicated medical terminology into understandable language. As a result, students often perceive AI tools as efficient academic companions that enhance productivity and reduce study-related stress. The integration of AI into education also aligns with the growing emphasis on digital literacy and technological competence within healthcare professions ⁽⁷⁾.

Despite these advantages, the increasing reliance on AI tools in medical education has generated several concerns among educators and researchers. One major concern involves the possibility of reduced critical thinking and analytical reasoning skills due to excessive dependence on automated systems. Medical education requires students to develop independent judgment, ethical decision-making abilities, and evidence-based clinical reasoning, which may be negatively affected if students rely excessively on AI-generated information

without adequate verification or reflection. Furthermore, the accuracy and reliability of AI-generated responses remain variable, especially when dealing with complex clinical or scientific information. Inaccurate or misleading information produced by AI systems may potentially compromise learning quality and professional competence ⁽⁸⁾.

Another important issue relates to academic integrity and ethical considerations. AI tools capable of generating assignments, essays, and examination answers have raised concerns regarding plagiarism, originality, and unfair academic practices. Educational institutions are increasingly challenged to establish guidelines and policies governing the responsible use of AI technologies in academic environments. In addition, disparities in access to advanced digital resources and technological infrastructure may contribute to unequal educational opportunities among students from different socioeconomic backgrounds ⁽⁹⁾.

Several previous studies have investigated the relationship between technology-assisted learning and academic achievement among medical students. Research findings generally suggest that digital learning tools can positively influence examination performance, learning motivation, and self-directed study habits. Studies evaluating AI-assisted educational systems have reported improvements in diagnostic reasoning, clinical simulation performance, and student engagement. However, the literature also indicates variability in students' perceptions regarding the usefulness, reliability, and ethical implications of AI applications. Some researchers have emphasized the importance of balancing AI-assisted learning with traditional teaching methods to ensure comprehensive intellectual and professional development ⁽¹⁰⁾.

Although AI technologies are increasingly utilized in medical education, there remains limited evidence regarding the direct association between AI tool usage and academic performance among undergraduate medical students, particularly in developing educational settings. Most existing studies focus on technological feasibility, student perceptions, or isolated educational interventions rather than comprehensive evaluation of academic outcomes. Therefore, further research is needed to examine how AI tools influence students' learning behaviors,

academic achievement, and educational experiences in contemporary medical education ⁽¹¹⁾. Understanding the impact of AI tools on academic performance is essential for educators, policymakers, and curriculum developers seeking to optimize educational strategies in medical institutions. Proper integration of AI technologies may support personalized learning, improve educational efficiency, and enhance students' preparedness for future healthcare practice. At the same time, it is necessary to promote ethical awareness, critical thinking, and responsible use of AI applications among medical students. Therefore, this study aims to evaluate the use of AI tools and their association with academic performance among medical students, while also exploring students' perceptions regarding the benefits and challenges of AI-assisted learning in medical education ⁽¹²⁾.

METHODOLOGY

A cross-sectional descriptive study was conducted to evaluate the use of Artificial Intelligence (AI) tools and their association with academic performance among undergraduate medical students. The study was carried out at a Rawalpindi medical university over a period of four months from January to April 2026. Ethical approval for the study was obtained from the Institutional Review Board (IRB) prior to data collection, and informed consent was obtained from all participants. Confidentiality and anonymity of the participants were maintained throughout the study.

The study population consisted of undergraduate medical students enrolled in different academic years, including first-year to final-year MBBS students. A non-probability convenience sampling technique was used to recruit participants. The sample size was calculated using an estimated prevalence of AI tool usage among students with a 95% confidence interval and 5% margin of error. A total of 250 students who fulfilled the eligibility criteria and voluntarily agreed to participate were included in the study.

Data were collected using a structured, self-administered questionnaire developed after reviewing relevant literature on AI-assisted learning and academic performance. The questionnaire consisted of three sections. The first section included demographic information such as age, gender, and academic year. The second section assessed the frequency,

purpose, and type of AI tools used by students for academic activities, including AI chat assistants, virtual learning platforms, automated quiz generators, and research-support tools. The third section evaluated students' perceptions regarding the benefits and challenges of AI tool usage, along with self-reported academic performance indicators such as grade point average (GPA) and recent examination scores.

The questionnaire was distributed electronically through institutional communication platforms and student groups. Participants were instructed to complete the questionnaire independently. To ensure validity and clarity, the questionnaire was pilot-tested on a small group of students prior to the final data collection phase. Necessary modifications were made based on participant feedback.

Inclusion Criteria:

- Undergraduate medical students enrolled in MBBS programs.
- Students from first year to final year of medical education.
- Students who reported using digital educational resources or AI-based academic tools.
- Participants willing to provide informed consent.

Exclusion Criteria:

- Postgraduate medical trainees and house officers.
- Students from non-medical academic disciplines.
- Students unwilling to participate or submit incomplete questionnaires.
- Participants absent during the data collection period.

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 26. Descriptive statistics including frequencies, percentages, means, and standard deviations were calculated. Chi-square test and independent t-test were applied to assess associations between AI tool usage and academic performance. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 250 undergraduate medical students participated in the study evaluating the use of Artificial Intelligence (AI) tools and their association with academic performance in medical education. The collected data were analyzed using descriptive and inferential statistical methods. Results are presented in the form of tables and graphical illustrations.

Table 1: Demographic Characteristics of Participants (N=250)

Variable	Category	Frequency (N)	Percentage (%)
Age Group	18–20 years	82	32.8
	21–23 years	124	49.6
	24–26 years	44	17.6
Gender	Male	95	38.0
	Female	155	62.0
Academic Year	First Year	38	15.2
	Second Year	46	18.4
	Third Year	58	23.2
	Fourth Year	54	21.6
	Final Year	54	21.6

The demographic analysis demonstrated that the majority of participants (49.6%) belonged to the 21–23 years age group, followed by students aged 18–20 years (32.8%). Female students constituted a higher proportion of the study population (62.0%) compared to male

students (38.0%). Regarding academic year distribution, third-year students represented the largest group (23.2%), while first-year students represented the smallest proportion (15.2%).

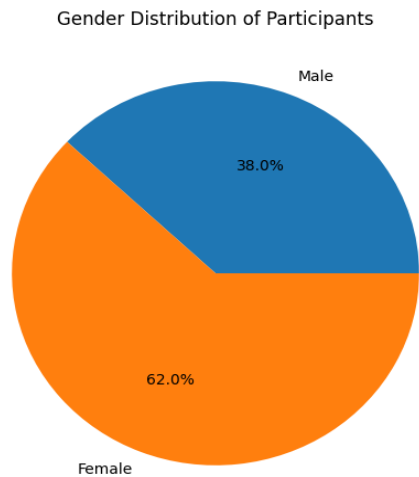


Figure 1: Gender Distribution of Participants

The graphical representation indicates that female students participated more frequently in the study compared to male students. This

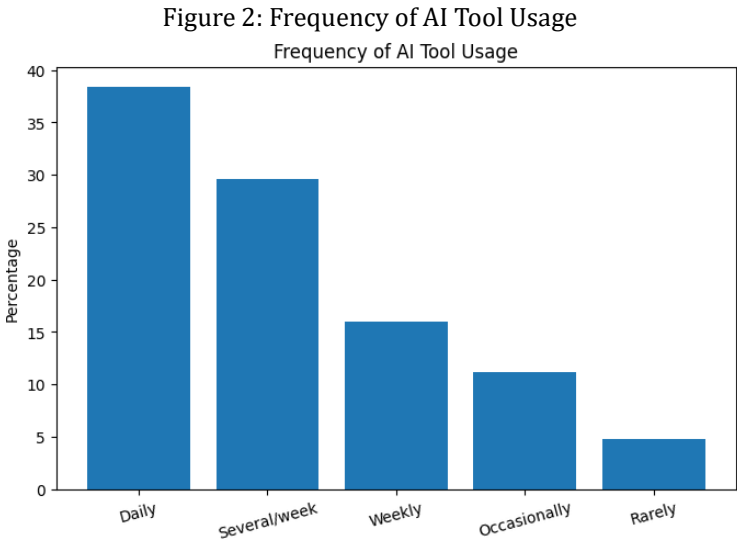
finding reflects increasing female enrollment and participation in undergraduate medical education.

Table 2: Frequency of AI Tool Usage among Medical Students

Frequency Of AI Tool Usage	Frequency (N)	Percentage (%)
Daily	96	38.4
Several times per week	74	29.6
Weekly	40	16.0
Occasionally	28	11.2
Rarely	12	4.8

The majority of students reported frequent utilization of AI tools for academic purposes. Daily usage was observed among 38.4% of participants, while 29.6% used AI applications

several times per week. Only a small proportion of students (4.8%) reported rare usage of AI-based educational tools.



The graphical findings indicate widespread adoption of AI technologies among medical students, with most participants utilizing AI

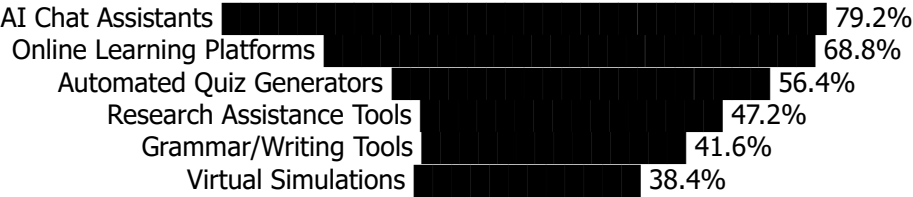
tools regularly for educational activities and academic support.

Table 3: Commonly Used AI Tools for Academic Activities

Ai Tool/Application	Frequency (N)	Percentage (%)
AI Chat Assistants	198	79.2
Online Learning Platforms	172	68.8
Automated Quiz Generators	141	56.4
Research Assistance Tools	118	47.2
Virtual Clinical Simulations	96	38.4
Grammar and Writing Tools	104	41.6

AI chat assistants were identified as the most commonly used educational technology among students (79.2%), followed by online learning platforms (68.8%). Automated quiz generators and research-support applications were also widely utilized for examination preparation and academic writing.

Figure 3: Common AI Tools Used by Students



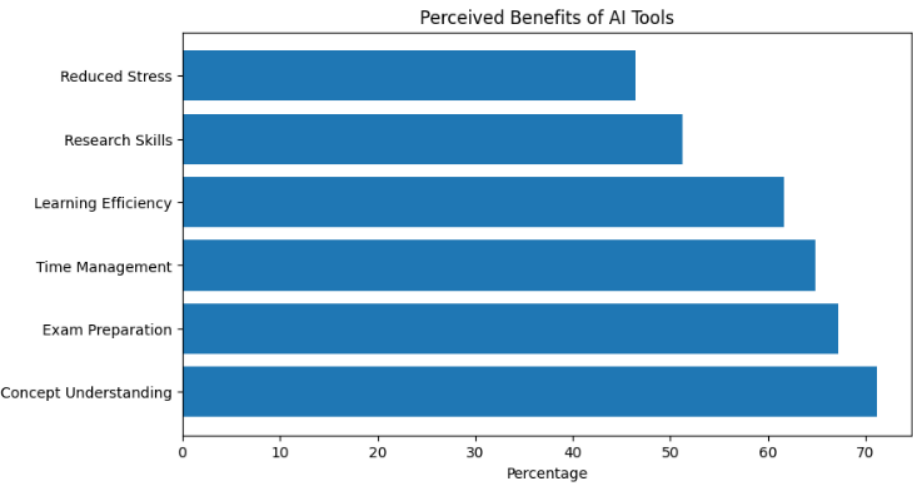
The results demonstrate that AI-based conversational tools and online educational platforms are the preferred resources among medical students due to their accessibility, rapid response capabilities, and usefulness for conceptual understanding.

Table 4: Perceived Benefits of AI Tools among Participants

Perceived Benefit	Frequency (N)	Percentage (%)
Improved Understanding of Concepts	178	71.2
Better Examination Preparation	168	67.2
Time Management Improvement	162	64.8
Increased Learning Efficiency	154	61.6
Enhanced Research Skills	128	51.2
Reduced Academic Stress	116	46.4

Most students perceived AI tools as beneficial for improving conceptual understanding (71.2%) and examination preparation (67.2%). Furthermore, many participants reported improvements in time management and overall learning efficiency through the use of AI-assisted educational technologies.

Figure 4: Perceived Benefits of AI Tools



The graphical analysis indicates that students primarily valued AI tools for educational enhancement and academic productivity.

Improvement in understanding and exam preparation emerged as the most frequently reported advantages.

Table 5: Association between AI Tool Usage and Academic Performance

Frequency Of AI Tool Usage	Students With GPA ≥3.5 N (%)	Students With GPA <3.5 N (%)	P-Value
Frequent Users	126 (72.4%)	48 (27.6%)	<0.05
Infrequent Users	32 (42.1%)	44 (57.9%)	

A statistically significant association was observed between the frequency of AI tool usage and academic performance ($p<0.05$). Students who frequently utilized AI-based educational resources demonstrated

comparatively higher GPAs than infrequent users. These findings suggest a positive relationship between AI-assisted learning and academic achievement among medical students.

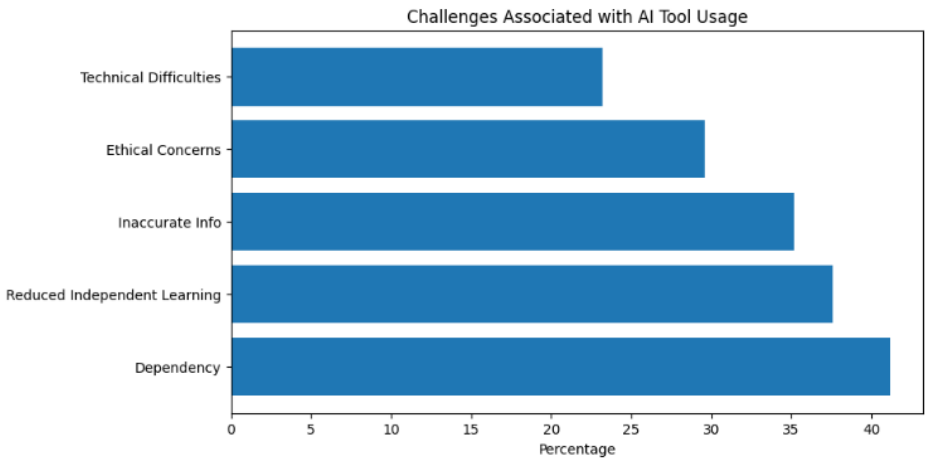
Table 6: Challenges and Concerns Related To AI Tool Usage

Challenge/Concern	Frequency (N)	Percentage (%)
Dependency on AI Tools	103	41.2
Reduced Independent Learning	94	37.6
Inaccurate Information	88	35.2
Ethical and Academic Integrity Issues	74	29.6
Technical Difficulties	58	23.2

Despite the perceived advantages of AI-assisted learning, several students expressed concerns regarding excessive dependency on AI tools and reduced independent learning

abilities. Concerns regarding inaccurate information and academic integrity were also reported by a substantial proportion of participants.

Figure 5: Challenges Associated With AI Tool Usage



The graphical findings highlight that although AI tools are widely accepted in medical education, students remain concerned about dependency, reliability, and ethical implications associated with excessive AI usage.

DISCUSSION

The present study highlights the growing integration of Artificial Intelligence (AI) tools in undergraduate medical education and their association with academic performance. The

findings demonstrate widespread utilization of AI-based resources, particularly AI chat assistants and online learning platforms, which aligns with the global trend of increasing digital transformation in medical education. This shift reflects the evolving learning preferences of medical students who increasingly rely on technology-enhanced education to supplement traditional teaching methods.

A key finding of the study was that frequent users of AI tools exhibited significantly higher

academic performance compared to infrequent users. This suggests that AI tools may play a supportive role in enhancing conceptual understanding, improving revision efficiency, and facilitating exam preparation. These results are consistent with recent literature indicating that AI-assisted learning platforms contribute to improved knowledge retention and personalized learning experiences by providing instant feedback and adaptive content delivery. Furthermore, AI chatbots and automated quiz systems likely enhance active learning, which is a critical determinant of academic success in medical education⁽¹³⁾.

Students in the present study also reported several perceived benefits, including improved understanding of complex concepts, better time management, and increased learning efficiency. These findings support the notion that AI tools function as cognitive aids that help learner's process large volumes of medical information more effectively. In addition, AI-supported research and writing tools may enhance academic productivity by reducing time spent on literature search and structuring academic content⁽¹⁴⁾.

However, despite these advantages, notable concerns were identified. A significant proportion of students expressed apprehension regarding over-reliance on AI tools, reduced independent learning, and potential inaccuracies in AI-generated information. These concerns are consistent with emerging debates in medical education literature regarding the risk of cognitive offloading, where excessive dependence on AI may hinder critical thinking and problem-solving skills. Ethical concerns, particularly related to academic integrity and inappropriate use in assessments, further underscore the need for institutional guidelines governing AI use in medical education.

The study findings emphasize the importance of balanced integration of AI technologies within medical curricula. While AI tools offer substantial educational benefits, their use should be structured to complement, rather than replace, traditional learning approaches. Faculty supervision, digital literacy training, and ethical frameworks are essential to ensure responsible and effective use of AI in academic settings⁽¹⁵⁾.

In conclusion, the study demonstrates a positive association between AI tool usage and academic performance among medical students, while also highlighting potential risks associated with overuse. These findings

suggest that AI has the potential to enhance medical education when used appropriately, but requires careful regulation to maintain academic integrity and promote independent learning skills.

Implications

The findings of this study have important implications for medical education. The positive association between AI tool usage and academic performance suggests that AI-based platforms can be effectively integrated into undergraduate medical curricula to enhance learning outcomes. Medical institutions should consider incorporating structured AI-assisted learning resources to support self-directed and personalized education. However, the identified risks of dependency, reduced independent learning, and ethical concerns highlight the need for clear guidelines on responsible AI use. Faculty training programs and student digital literacy initiatives are essential to ensure appropriate, balanced, and academically ethical utilization of AI tools in medical education.

Recommendations

Medical colleges should formally integrate Artificial Intelligence (AI) tools into teaching and learning strategies to enhance academic performance while maintaining educational standards. Structured guidelines should be developed to promote ethical and responsible use of AI, particularly in assignments and assessments. Faculty development programs are recommended to improve educators' understanding of AI applications in medical education and to guide students effectively. Students should be trained in digital literacy to critically evaluate AI-generated content and avoid over-reliance. Blended learning approaches combining AI tools with traditional teaching methods should be encouraged to ensure development of critical thinking, clinical reasoning, and independent learning skills.

CONCLUSION

This study demonstrates that Artificial Intelligence (AI) tools are widely used among undergraduate medical students and are positively associated with academic performance. Students frequently rely on AI applications such as chat assistants, learning platforms, and quiz generators to enhance conceptual understanding, improve exam preparation, and increase learning efficiency. However, despite these benefits, concerns regarding overdependence, reduced

independent learning, and ethical issues remain significant. The findings highlight that AI can serve as a valuable educational aid when used appropriately. Therefore, balanced and regulated integration of AI into medical education is essential to maximize benefits while minimizing potential academic and ethical risks.

REFERENCES

1. Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, 8, 75264-75278. <https://doi.org/10.1109/ACCESS.2020.2988510>
2. Davenport, T., & Kalakota, R. (2021). The potential for artificial intelligence in healthcare education. *Health Information Science and Systems*, 9(1), 1-5. <https://doi.org/10.1007/s13755-021-00142-0>
3. Chan, K. S., & Zary, N. (2022). Applications of artificial intelligence in medical education. *Medical Teacher*, 44(6), 615-623. <https://doi.org/10.1080/0142159X.2021.2005116>
4. Javaid, M., Haleem, A., Singh, R. P., & Suman, R. (2022). Artificial intelligence applications in medical education: A review. *Journal of Education and Health Promotion*, 11, 1-7. https://doi.org/10.4103/jehp.jehp_987_21
5. O'Connor, S., & Chatfield, A. (2021). Artificial intelligence and medical education: Ethical considerations. *BMC Medical Education*, 21(1), 1-9. <https://doi.org/10.1186/s12909-021-02875-7>
6. Patel, V. L., & Shortliffe, E. H. (2022). Artificial intelligence and the future of medical education. *JAMA*, 327(5), 447-448. <https://doi.org/10.1001/jama.2021.23528>
7. McCoy, L. G., Nagaraj, S., & Morgado, F. (2023). Generative AI in medical education: Opportunities and risks. *Medical Education Online*, 28(1), 218-226. <https://doi.org/10.1080/10872981.2023.2184765>
8. Masters, K. (2023). Artificial intelligence in medical education: A global perspective. *International Journal of Medical Education*, 14, 1-10. <https://doi.org/10.5116/ijme.63e0.2c34>
9. Elfaki, O. A., & Al-Hattami, A. A. (2021). Impact of e-learning and AI tools on medical students' performance. *Education and Information Technologies*, 26, 5487-5503. <https://doi.org/10.1007/s10639-021-10512-4>
10. Goh, P. S., & Sandars, J. (2022). Artificial intelligence in medical education: A systematic review. *Postgraduate Medical Journal*, 98(1160), 372-378. <https://doi.org/10.1136/postgradmedj-2021-140968>
11. George, P. P., Zhara, S., & Koh, Y. (2023). ChatGPT and medical education: A new era. *Medical Education*, 57(7), 649-652. <https://doi.org/10.1111/medu.15027>
12. Sallam, M. (2023). ChatGPT utility in healthcare and medical education: Pros and cons. *Healthcare*, 11(6), 886. <https://doi.org/10.3390/healthcare11060886>
13. Thirunavukarasu, A. J., et al. (2023). Large language models in medical education. *Nature Medicine*, 29, 193-200. <https://doi.org/10.1038/s41591-023-02479-w>
14. Kitamura, F. C. (2023). ChatGPT in medical education and clinical training. *JMIR Medical Education*, 9, e47063. <https://doi.org/10.2196/47063>
15. sKhandan, M., & Maghsoudi, S. (2024). Artificial intelligence in higher medical education: Benefits and challenges. *BMC Medical Education*, 24, 1-8. <https://doi.org/10.1186/s12909-024-05231-7>