

Artificial Intelligence in Medical Education: A Cross-Sectional Study of Awareness, Perceptions, and Adoption Barriers among Undergraduate Medical Students in India

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ABSTRACT

Background: Artificial intelligence (AI) is revolutionising healthcare, but its integration into Indian undergraduate medical curricula remains nascent. Understanding student perspectives is critical for effective pedagogical reform.

Objectives: This study aimed to assess AI awareness and knowledge, evaluate perceptions toward its integration in medical education, and identify perceived barriers to adoption among undergraduate medical students.

Methods: A cross-sectional, questionnaire-based study was conducted (January–March 2026) among 324 MBBS students (2nd to final year) at an Indian medical college. A structured, pre-validated questionnaire was used to evaluate awareness, usage patterns, perceptions, and barriers (5-point Likert scale). Descriptive statistics and chi-square tests were used for the statistical analysis, and the level of significance was set at $p < 0.05$.

Results: Participants (mean age 22.71 ± 1.59 years; 55.6% male) reported 77.5% prior AI exposure, though only 12.04% claimed high familiarity. AI chatbots were the primary tools used (92.3%). Students demonstrated favourable perceptions regarding AI's utility in clinical decision-making and learning while largely rejecting the notion that it would replace educators. Key barriers included data privacy concerns and output reliability. Prior AI exposure significantly correlated with positive perceptions ($\chi^2 = 11.948$, $p = 0.018$). Most students advocated for formal AI training and ethical guidelines within the medical curriculum.

Conclusion: Indian medical students show positive attitudes toward AI but lack deep technical familiarity. To address ethical and infrastructural barriers, structured curricular integration focusing on foundational AI competencies is essential for preparing future physicians.

Keywords: Artificial intelligence, medical education, students, attitude, technology adoption

INTRODUCTION

The incorporation of Artificial Intelligence (AI) into healthcare is precipitating a significant transformation in contemporary medicine, fundamentally altering established methodologies via sophisticated diagnostics, tailored treatments, and enhanced patient management. Given the increasing prevalence of AI applications, including machine learning algorithms and generative models like ChatGPT, within educational settings and medical institutions, the educational frameworks designed to train future medical professionals require modification. The World Medical Association and allied organizations advocate for the inclusion of AI education within medical school curricula, thereby ensuring that newly graduated doctors can utilize these technologies safely and effectively.^{1,2}

Furthermore, the swift digitalization of healthcare in India presents a significant opportunity for the adoption of AI in medical education. In Indian medical education, the formal inclusion of artificial intelligence (AI) training alongside traditional teaching methods is still in its early stages. Undergraduate medical students constitute the principal stakeholders in this technological shift; their existing knowledge base and perspectives will significantly influence the effective integration of AI into clinical practice. Recent research indicates that students generally exhibit a favourable disposition toward AI's capacity to enhance learning efficiency and diagnostic precision, yet a substantial knowledge deficit persists.³

Furthermore, significant apprehensions surround the convergence of AI and medical education. Students frequently voice valid concerns regarding the ethical implications of AI, including data privacy, algorithmic bias, and the potential violation of professional confidentiality. A significant concern centres on the potential for excessive reliance on AI-driven systems to diminish critical thinking skills, impair interpersonal connections, and ultimately

undermine the empathetic dimensions of the doctor-patient relationship. While there is widespread consensus that AI should complement, rather than supplant, conventional pedagogical approaches and clinical decision-making, comprehensive assessments of Indian medical students' preparedness and the challenges they perceive regarding AI integration remain limited. A thorough understanding of these viewpoints is essential for creating balanced, evidence-based training programs for medical faculty and those who develop curricula.^{4,5}

Therefore, this cross-sectional study examines and evaluates the viewpoints, understanding, and specific challenges related to using artificial intelligence in medical education, focusing on undergraduate medical students.

This study clarifies the perceived benefits and drawbacks, offering practical suggestions for successfully integrating AI technologies with existing teaching methods. The goal is to cultivate a medical workforce prepared for future challenges.

Objectives

1. To assess the level of awareness and foundational knowledge of Artificial Intelligence concepts and applications among undergraduate medical students.
2. To evaluate the perceptions and attitudes of undergraduate medical students toward the integration of AI-driven tools alongside traditional medical education teaching methodologies.
3. To identify the specific challenges and barriers perceived by medical students regarding the formal adoption of AI in their academic curriculum.

MATERIALS AND METHODS

Planning of the Study

An institutional based study was planned to assess medical students' perceptions, awareness, and adoption challenges regarding artificial intelligence (AI) in medical education at the United Institute of Medical Sciences (UIMS), Prayagraj.

Study Design

Cross-Sectional Study

Study setting

The study was carried out among undergraduate medical students (MBBS) United Institute of Medical Sciences from January 2026 to March 2026.

Study participants

Medical students (MBBS students) from 2nd Professional year to Final Professional year were included to ensure diverse perspectives.

Inclusion criteria

1. Medical students currently enrolled in MBBS curriculum of the medical college
2. Provide informed consent

Exclusion criteria

- Students who did not complete the questionnaire.
- First Professional year medical students
- Interns or postgraduate students.

Sample size

There were a total 450 students in the 2nd year, 3rd year and final year. Participation was voluntary due to which no randomization could be insured. Out of 450 medical students in the institution, 324 students completed their questionnaire, so 324 participants were analysed. Participants were recruited via institutional communication platforms (e.g., WhatsApp groups, email)

Data collection tool

Data were collected using a structured, self-administered questionnaire developed after literature review and expert validation.

The questionnaire consisted of 4 sections:

1. Demographic Details
 - Age, gender, academic year
2. Awareness and Knowledge of AI
 - Basic understanding of AI concepts
 - Sources of information about AI
3. Perceptions Toward AI in Medical Education
 - Measured using a 5-point Likert scale (Strongly Agree to Strongly Disagree)
 - Questions on usefulness, effectiveness, and future role
4. Adoption Challenges and Barriers
 - Lack of training
 - Limited access to AI tools
 - Ethical concerns
 - Curriculum gaps

Data collection procedure

The questionnaire was distributed online using platforms such as Google Forms. Participation was voluntary, and informed consent was obtained electronically before starting the survey.

Data Analysis ^{6,7}

Data were entered into Microsoft Excel and analysed using available software. Descriptive statistics (mean, standard deviation, percentages) were used. Inferential statistics (Chi-square test) was applied to assess associations. A p-value < 0.05 was considered statistically significant. A Likert scale (Strongly agree, Agree, Neutral, Disagree and Strongly Disagree) was used for perceptions, challenges, and opinions of medical students.

Ethical Consideration: The study was approved by institutional ethical committee (UIMS/IEC/EC/2025/24)

RESULTS

Table 1- Socio Demographic Information of Study Participants

Mean Age	22.71(Mean)	1.59 (Standard Deviation)
Gender	Frequency	Percent
Male	180	55.6
Female	144	44.4
Year of Study	Frequency	Percent
2	71	21.9

3	133	41.0
4	120	37.0
Prior Experience with AI Tools in Education	Frequency	Percent
Yes	251	77.5
No	73	22.5
Total	324	100.0

Table 1 presents the demographic characteristics and prior experience with AI tools among the study participants. The mean age of the respondents was 22.71 years (ranging from 19 to 29) with a standard deviation of 1.59, indicating that most participants were within a narrow age range typical of undergraduate students. In terms of gender distribution, a relatively

balanced gender representation was seen, with male students constituted most of the sample (55.6%). With respect to prior experience using AI tools in education, a substantial majority of the participants (77.5%) reported having previous experience. This suggests a high level of exposure to AI tools among the students.

Table 2 – Awareness and Usage of AI-Based Educational Tools among Study participants

How familiar are you with AI- driven learning tools in medical education	Frequency	Percent
Not at all familiar	23	7.10
Slightly familiar	153	47.22
Moderately familiar	109	33.64
Very familiar	39	12.04
How you used AI-based tools for medical learning or teaching	Frequency	Percent
Yes, regularly	84	25.9
Occasionally	197	60.8
Rarely	34	10.5
Never	09	2.8
Which AI based tools have you used		
Chat GPT or other AI chatbots	299	92.3
AI-powered medical simulators	10	3.1
AI-driven question banks (e.g., UptoDate, Amboss)	10	3.1
AI-based diagnostic applications	03	0.9
Others	02	0.6
Total	324	100.0

Table 2 summarizes participants' familiarity with AI-driven learning tools in medical education, their patterns of use, and the types of AI-based tools they have utilized. Regarding familiarity with AI-driven learning tools, nearly half of the respondents (47.22%) reported being slightly familiar. A smaller proportion (12.04%) described themselves as very familiar with these tools. Only 7.1% reported being not at all familiar, suggesting that most participants had at least some exposure to AI-driven learning tools. In terms of usage, most participants reported using AI-based tools occasionally (60.8%). About one-quarter participants indicated that they used these tools regularly, very small proportion (2.8%) stated that they had

never used AI-based tools for medical learning or teaching. These findings indicate that while regular use is not universal, AI tools are commonly incorporated into medical education on at least an occasional basis. With respect to the specific types of AI-based tools used, an overwhelming majority of respondents (92.3%) reported using ChatGPT or other AI chatbots, making these the most widely adopted tools. In contrast, the use of more specialized AI applications was minimal. Only 3.1% reported using AI-powered medical simulators, and a similar proportion used AI-driven question banks such as Up-to-date or AMBOSS. Very few participants

reported using AI-based diagnostic applications (0.9%).

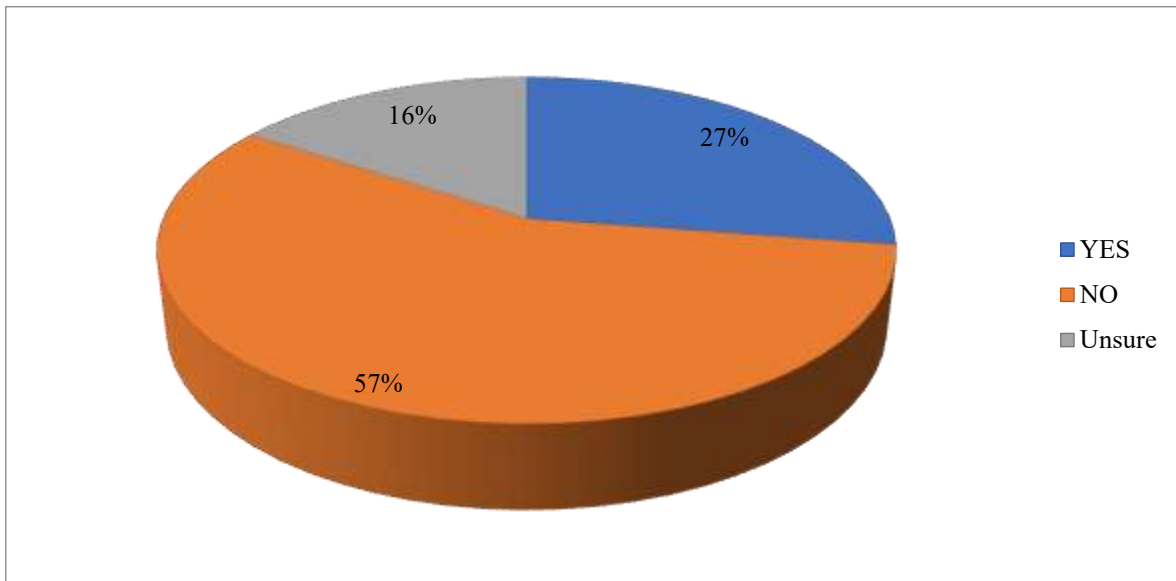


Figure 1 - AI will replace the role of Educators in future

The figure presents respondents' opinions on whether artificial intelligence will replace the role of educators in the future. A clear majority of respondents (57%) believe that AI will not replace educators. This suggests that most people still value the

human aspects of teaching—such as personal interaction, emotional support, and adaptability—which they may feel AI cannot fully replicate. Meanwhile, 27% of respondents think that AI will replace educators.

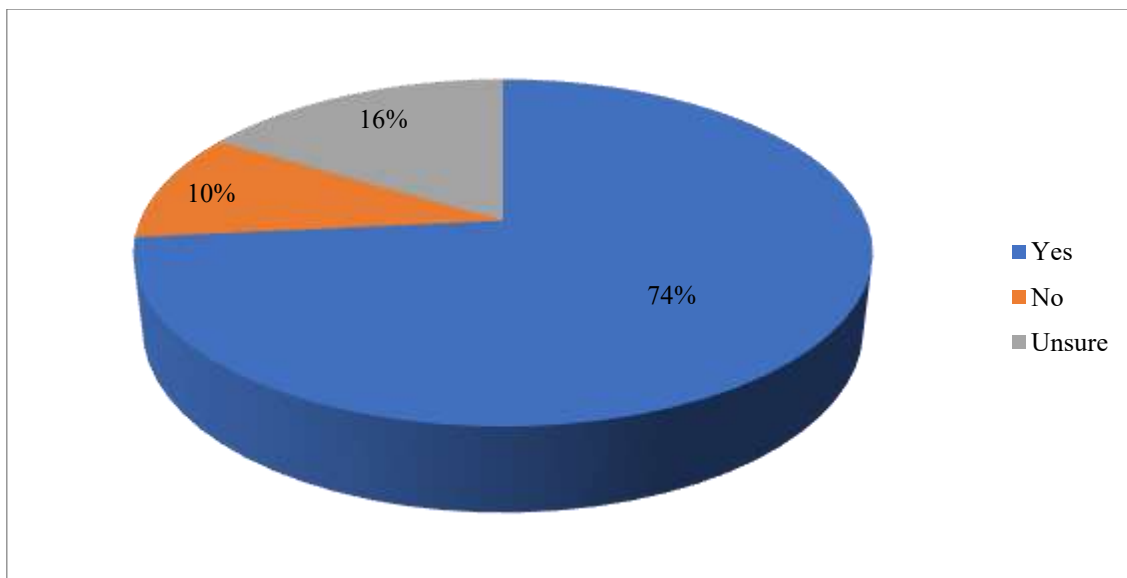


Figure 2 - Willing to receive formal training on AI-based educational tools

The pie chart shows respondents' willingness to receive formal training on AI-based educational tools. The results demonstrate a high level of positive attitude and readiness among respondents toward

adopting AI-based educational tools through formal training. This suggests a strong opportunity for institutions to introduce training programs, as the majority are willing and likely to benefit from them.

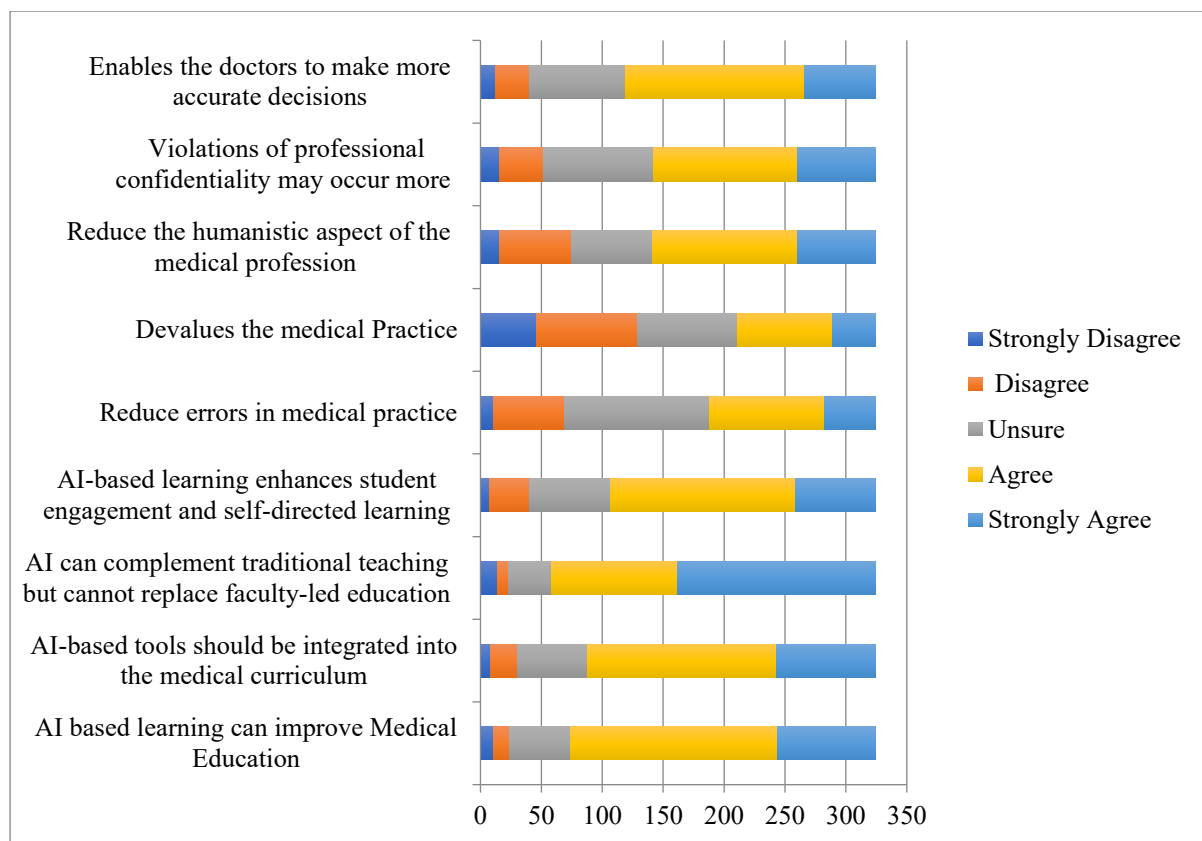


Figure 3 – Perception of AI in Medical Education

Figure 3 demonstrate an overall favourable perception of artificial intelligence among medical students. Most respondents supported the integration of AI into the medical curriculum and recognized its role in enhancing learning, improving clinical decision-making, and reducing errors. AI was largely viewed as a supportive tool that complements, but does not replace, traditional faculty-led teaching. At the same time, notable concerns were expressed regarding potential risks, particularly related to breaches of professional confidentiality, reduction in the humanistic aspect of care, and possible devaluation of the medical profession. A proportion of students also remained uncertain about these implications.

Figure 4 highlight several key barriers to the adoption of AI-based education among medical students. The most prominent concerns relate to data privacy and security,

as well as the accuracy and reliability of AI-generated information, indicating apprehension about the trustworthiness and ethical implications of these technologies. A strong preference for human instructors was also observed, suggesting that students continue to value traditional pedagogical approaches. Economic and infrastructural constraints, including the cost of accessing AI-based resources and limited availability of tools, emerged as additional challenges. Furthermore, resistance to change from conventional teaching methods and concerns about reduced interaction with peers and faculty reflect perceived impacts on the learning environment. Technical barriers were also evident, with a proportion of students reporting inadequate skills to effectively use AI tools. Difficulty in adapting to digital learning resources was noted by some respondents, although this was less prominent compared to other concerns

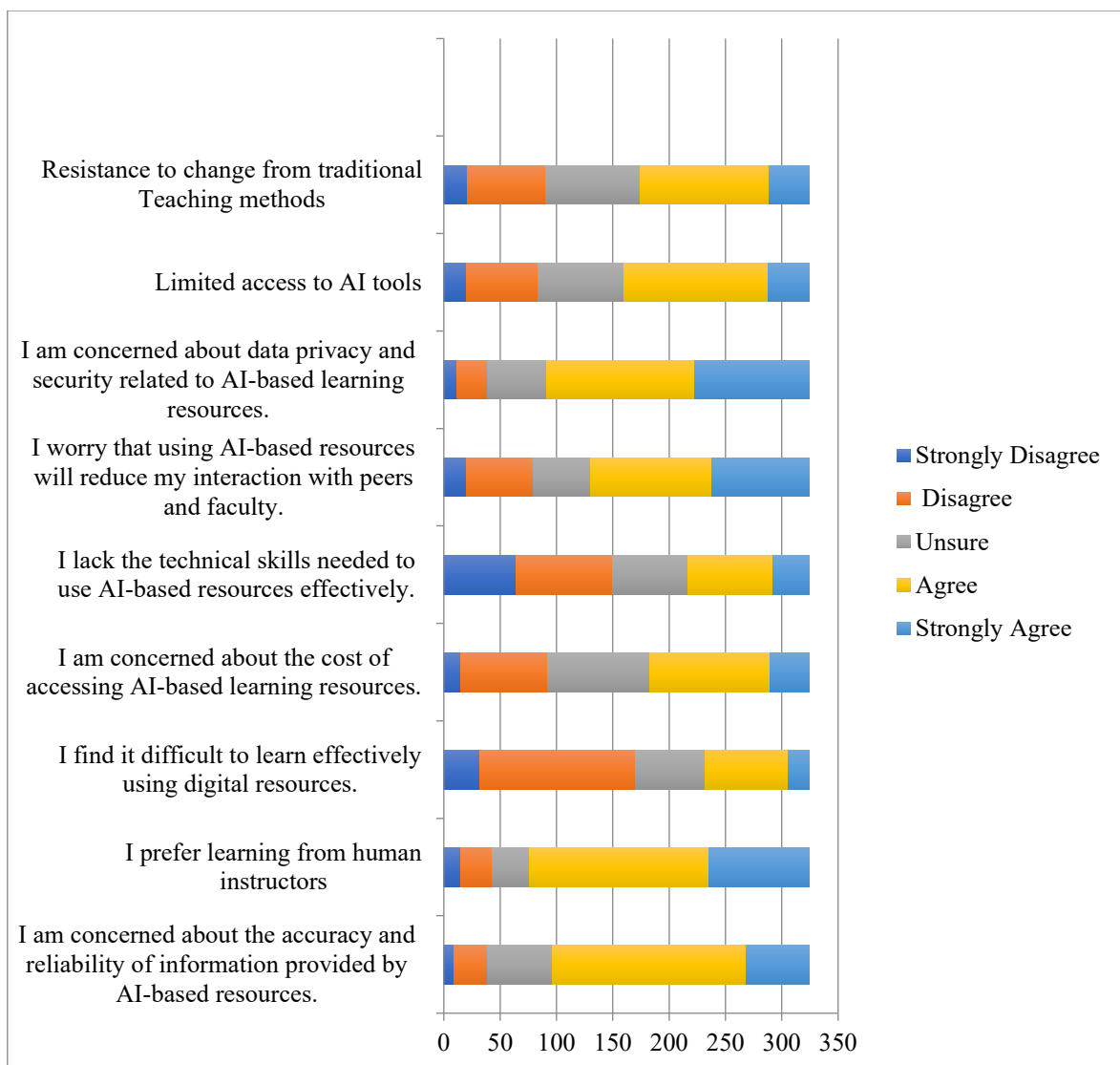


Figure 4 – Challenges in Adopting AI-Based Education

Table 3 – Cross Tabulation of Prior experience with AI tools in education and AI-based learning can improve medical education outcomes.

	Prior Experience with AI			Total
	Yes	No		
AI-based learning can improve medical education	Strongly Disagree	11 (100 %)	0 (0%)	11 (100 %)
	Disagree	12 (92.3 %)	01 (7.7 %)	13 (100 %)
	Unsure	31 (62.0 %)	19 (38.0 %)	50 (100 %)
	Agree	134 (78.8 %)	36 (21.2 %)	170 (100 %)
	Strongly Agree	63 (78.8 %)	17 (21.2 %)	80 (100 %)

Pearson Chi-square value – 11.948, p value = 0.018

This table examines the association between prior experience with AI and the perception that AI-based learning can improve medical education. The chi-square test indicates a statistically significant association between prior AI experience and attitudes toward AI-

based learning ($\chi^2 = 11.948$, $df = 4$, $p = 0.018$). This suggests that prior exposure to AI significantly influences participants' perceptions, with experienced individuals being more inclined toward favourable views.

Table 4 - Opinions on suggested topics on AI to be included in medical curriculum

S. No.	Questions asked in the Questionnaire	Definitely should be included	Would be good	unsure	Not a must	No need
1	Knowledge and skills about AI applications	102	117	35	48	22
2	Training to prevent and solve ethical problems that may arise with AI applications	97	98	56	57	16
3	Wide use of health mobile applications in preventive health care	78	111	51	62	22
4	AI analysis that helps to understand and predict health phenomena in the community	63	140	54	48	19
5	AI assisted risk analysis for diseases	79	110	78	40	17
6	AI assisted survival analysis and patient isolation in epidemics	70	112	73	43	26
7	AI assisted emergency response	86	98	59	58	23
8	AI assisted diagnosis and treatment of disease	47	97	61	74	45
9	AI in epidemiological research	80	123	43	52	26
10	Applications that will increase patient's compliance with treatment	78	99	66	50	31
11	Applications for reducing medical errors	76	114	75	39	20

Table 4 findings indicate strong overall support for incorporating AI-related topics into the medical curriculum, with most respondents favouring inclusion across domains. Core areas such as knowledge and skills in AI applications, ethical training, and AI in epidemiological research received the highest endorsement, reflecting a clear preference for foundational competencies and responsible use.

Applied domains, including AI-assisted risk analysis, emergency response, and public health applications, were also well supported, suggesting recognition of AI's relevance in clinical and community settings. In contrast, relatively lower support was observed for AI-assisted diagnosis and treatment, indicating possible hesitation toward reliance on AI in direct clinical decision-making.

A moderate proportion of respondents remained uncertain across several topics, particularly in more specialized applications, highlighting gaps in awareness or familiarity.

DISCUSSION

The present study aimed to assess the awareness, foundational knowledge,

perceptions, and challenges regarding artificial intelligence (AI) integration among undergraduate medical education. As AI technologies rapidly evolve, understanding learner perspectives is crucial for effective curriculum development and the responsible adoption of these tools in clinical and academic environments.

Awareness and Usage Patterns

Our findings reveal a high level of exposure to AI, with a substantial majority of participants (77.5%) reporting prior experience with AI tools in their education. This high prevalence is consistent with recent literature; for example, a cross-sectional study at AIIMS Rishikesh reported that 91.6% of medical students used AI tools for academic purposes.⁴ Similarly, a pan-India survey noted that 80.7% of medical students possessed a basic understanding of AI.⁸

When examining specific usage patterns, an overwhelming 92.3% of our respondents utilized ChatGPT or other AI chatbots, while the use of specialized medical AI applications—such as diagnostic tools or medical simulators—remained minimal. The heavy reliance on general-purpose

chatbots indicates that students are primarily engaging in unstructured, inquiry-based learning. This trend is corroborated by a recent systematic review of Indian medical education, which highlighted that student engagement with generative AI is mostly informal and unstructured, focusing on clearing doubts and self-directed learning rather than structured clinical application.⁹

Perceptions and Attitudes Toward AI

Participants in our study held a highly positive view of AI's potential, with most agreeing or strongly agreeing that AI-based learning improves medical education outcomes. Notably, our cross-tabulation analysis demonstrated a statistically significant association between prior AI experience and favourable perceptions of AI-based learning ($p = 0.018$). This aligns with findings from Sarkar et al., who reported that familiarity with AI terminologies and prior training positively predicted students' overall attitudes and readiness towards AI.¹⁰

Despite this optimism, students do not view AI as a replacement for human educators. A clear majority (57%) believed that AI will not replace the role of educators, emphasizing the enduring value of human interaction, emotional support, and adaptability. Similar sentiments are prevalent across other cohorts; a Kerala-based study found that 69.2% of students feared AI could reduce the humanistic aspect of the medical profession.² Furthermore, a qualitative study from Jaipur highlighted concerns that increased reliance on AI could weaken the patient-doctor relationship and replace the essential human touch in healthcare settings.³

Challenges and Barriers to Adoption

While students recognize the benefits of AI, they also expressed significant reservations. The most prominent challenges identified in our study were concerns regarding data privacy, security, and the accuracy and reliability of AI-provided information. These apprehensions are strongly supported

by the AIIMS Rishikesh study, which identified content accuracy (72.1%) and data privacy (50.2%) as the primary concerns among medical students.⁴

Additionally, participants in our study were concerned that AI usage might reduce interaction with peers and faculty, posing a perceived risk to the collaborative aspects of learning. The fear of over-reliance on AI systems and a perceived lack of empathy was also highlighted as major drawbacks in the pan-India survey, where 49.2% and 43.7% of respondents, respectively, voiced these specific concerns.⁸ Practical barriers, such as limited access to AI tools and institutional resistance to changing traditional teaching methods, were also recognized as moderate hurdles to effective adoption.

Curriculum Integration and Training Needs

The recognition of both the utility and the limitations of AI drive a strong demand for formal education. Our results demonstrate a high level of readiness and positive attitude among respondents toward receiving formal training on AI-based educational tools.

When evaluating suggested curriculum topics, respondents strongly prioritized foundational knowledge and skills regarding AI applications, alongside training to prevent and solve ethical problems. The prioritization of AI ethics is highly consistent with the findings of Jackson et al., who reported that 79.4% of surveyed students perceived training on ethical problems arising from AI applications as necessary.² Additionally, our respondents showed strong support for including public health and epidemiological applications of AI in the curriculum, while expressing more caution regarding AI-assisted direct clinical diagnosis and treatment. These curriculum preferences underscore a critical gap between student readiness and current institutional offerings, highlighting the need for structured educational interventions that combine technical literacy with robust ethical frameworks.

Recommendation

Medical institutions should urgently formalize AI training within the undergraduate curriculum, shifting student engagement from informal chatbot usage toward structured, evidence-based academic applications. These programs must prioritize comprehensive modules on AI ethics, data security, and public health applications to mitigate prevalent concerns regarding information accuracy and professional confidentiality. Ultimately, AI should be integrated as a complementary pedagogical tool that enhances clinical reasoning while preserving the essential humanistic and empathetic foundations of faculty-led medical education.

CONCLUSION

Undergraduate medical students demonstrate substantial awareness and utilization of artificial intelligence, predominantly engaging with general-purpose chatbots for unstructured and inquiry-based learning. While students exhibit a highly positive disposition toward AI's potential to enhance educational outcomes—a perception significantly correlated with prior exposure—they firmly maintain that AI must complement rather than supplant human educators and the essential human touch in medicine. The optimal adoption of these technologies is currently impeded by significant and valid concerns regarding data privacy, information accuracy, and the potential erosion of collaborative peer and faculty interactions. Consequently, there is a strong readiness and demand for formal curricular integration; students prioritize foundational AI competencies, epidemiological applications, and rigorous ethical training over AI-assisted direct clinical diagnosis. To bridge the critical gap between student readiness and current pedagogical models, medical institutions must proactively develop structured, evidence-based curricula that cultivate both technical proficiency and ethical responsibility in the future healthcare workforce.

Declaration by Authors

Ethical Approval: Approved

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