ORIGINAL ARTICLE

KNOWLEDGE ABOUT THE USE OF ARTIFICIAL INTELLIGENCE AND ITS ETHICAL IMPLICATIONS AMONG MEDICAL STUDENTS

Qurat Ul Ain Zulfi, Sadia Rehman*, Raheela Rafique*, Nazneen Fatima, Ayesha Mehwish***, Aakash Kumar†**

Department of Community Medicine, Sialkot Medical College Sialkot, *Department of Biochemistry, **Final Year Student, ***Department of Anatomy, Bahria University of Health Sciences, Karachi, †Department of Surgery, Jinnah Postgraduate Medical Centre, Karachi, Pakistan

Background: Artificial Intelligence (AI) is changing healthcare practices at a rapid pace. As future medical professionals, medical students must comprehend its applications and ethical implications. The research is intended to evaluate the knowledge, familiarity, and attitudes of medical students towards Artificial Intelligence (AI) in medicine, with particular emphasis on its ethical aspects and possible influence on healthcare. **Methods:** This analytical research was carried out from 1 Jan to 30 Jun 2024, at Sialkot Medical College. Three hundred and sixty (360) medical students, from first to final year, were recruited using convenience sampling method. Data were gathered using a structured questionnaire on Google Forms, addressing demographic information, knowledge about AI, ethical issues, and self-efficacy in AI applications. Chi-square test was applied to assess associations between categorical responses, and $p<0.05$ was considered statistically significant. **Results:** Only 40% of students rated intermediate familiarity, indicating insufficient knowledge, even though 60% of students attended AI lectures. While strong worries about data privacy (85%) and accountability (80%) remained, no significant connections were detected on Chi-square analysis. The majority (85%) identified medical imaging as the primary application of AI, and 75% thought it improves patient outcomes. **Conclusion:** The results show increased mindfulness of AI in medical students and stresses the necessity of specific education on its ethical and clinical implications to ensure the responsible implementation of AI in medical practice.

Keywords: Artificial Intelligence, Medical education, Medical Students

Pak J Physiol 2025;21(4):53–6, **DOI:** https://doi.org/10.69656/pjp.v21i4.1875

INTRODUCTION

Artificial intelligence (AI) evolved over time in sporadic fashion, but more recently gained popularity with the innovation of deep learning and artificial neural networks (machine learning models composed of many layers of interconnected artificial neurons that can automatically learn patterns from data and make predictions). 'AI' as a term was first used by John McCarthy in 1955.[1] It has been defined as a machine that can exhibit intelligent behaviour, like perception, reasoning, learning, or communication, and be able to execute tasks that human beings normally accomplish. Artificial intelligence (AI) consists of three fundamental paradigms: symbolic (logic- and knowledge-based), statistical (probabilistic methods, machine learning), and sub-symbolic (embodied intelligence, search). Several problem domains (perception, thinking, knowledge, planning, and communication) are addressed by these paradigms.

Medical applications of AI remain an emotive issue that scientists are highly interested in, and it is being developed and enhanced continuously.[2] The application of AI in education has evolved considerably over the last 25 years, with technological developments such as 'teacher bots,' a teaching assistant responsible for presenting content, providing feedback, and tracking progress. This increasingly prevalent use in the educational sector has shown promise to assist students in identifying areas of knowledge deficit and receive targeted assistance, freeing teachers from routine tasks and enabling them to adapt students in a manner that facilitates personalized and adaptive learning process.[3]

Artificial intelligence (AI) is fast being used in medical and dental education to the advantage of both students and teachers. Simulated training and teaching using AI is one major application of AI in the field. With AI, the trainee can perform intricate surgeries on virtual patients without risking real patients' lives.[4] The type of practical learning is also flexible, allowing learners to follow the track on their own until they understand them. AI algorithms are a method of machine learning that can search vast amounts of health data to identify patterns and enhance diagnosis.[5] However, challenges in implementing AI into teaching medicine and dentistry need to be overcome.

There are fears that there can be a shortage of empathy and human interaction in medical therapy and diagnosis, and there is also a fear that students will be too dependent on AI and do not understand the importance of problem-solving and critical thinking. The reliability and unbiased operation of AI systems can also be compromised, possibly leading to wrong diagnoses or treatment plans.[6] The use of AI in dentistry education has shown promising outcomes in enhancing the teaching process and patient care. Virtual simulations allow dentistry students to conduct complex procedures like filling and root canal therapy without injuring actual patients. The adaptability of this type of hands-on training permits students to work at their own speed and repeat procedures until proficient.[7] Nevertheless, implementing AI into clinical and dental education is not without challenges. There can be concerns regarding the lack of human touch and compassion in medical diagnosis and treatments, whereas there is the risk that students can become overly dependent on AI and fail to hone their analytical and problem-solving skills.[8]

Students can choose to submit tasks they have not completed using automatic essay writers and online cheating software, and by modifying the scoring scale, they can artificially inflate their grades. Academic institutions are responsible for developing policies to avert such situations and uphold the integrity of the learning process.[9] Inclusion of AI in the curriculum of medical education offers pros and cons. The assessment of medical student's knowledge and competencies may be made unbiased, objective, and uniform through using AI algorithms while generating questions. To enhance the learning of students, AI algorithms can also make tests more individualized by reviewing student performance information and creating questions that focus on areas of weakness.[10]

This study attempts to evaluate medical students' knowledge and attitudes toward the application of Artificial Intelligence (AI) and its ethical issues in medicine. Through their level of familiarity and concerns, the research aims to determine areas of gaps in education and equip future health professionals with the readiness to accept AI integration. This will inform curriculum development and ethical education in medical training.

MATERIAL AND METHODS

This analytical study was carried out at Sialkot Medical College from Jan 1, 2024, to Jun 30, 2024 after taking ethical approval (MRC/IRB/24001). A total of 360 medical students were recruited by using a convenience sampling method after determining the sample size by Open epi website calculator.[3] The study population included students of the 1st, 2nd, 3rd, 4th, and final years of their medical course. Inclusion criteria involved being currently enrolled in the medical program, having completed at least one year of study, and having no prior formal education in applying Artificial Intelligence in medical practice. Students who refused to participate or had not satisfied the enrolment or study completion criteria were removed from the study. Data were collected through a guided questionnaire sent through Google Forms and evaluated the students' knowledge, acquaintance, and ethical aspects of AI in medicine. Participants were asked to rank their familiarity and frequency through Likert-scale questions.[10]

- Not familiar: 'I have little or no knowledge of AI; I cannot describe basic concepts or examples'.
- Slightly familiar: 'I have heard of AI and can recognize basic terms but cannot explain how it is used in clinical practice.'
- Moderately familiar: 'I can explain basic AI concepts, name some clinical applications, and interpret simple AI outputs with guidance.'
- Very familiar: 'I can critically appraise AI methods, apply AI tools in practice, and explain strengths/ limitations to colleagues.'

The gathered data were then analysed through relevant statistical procedures to make conclusions about the perceptions and knowledge of students concerning AI in medicine. Data obtained through the research were analysed through relevant statistical procedures to provide meaningful and reliable results. Descriptive statistics were computed in terms of frequencies and percentages to characterize the demographic background of the respondents, their level of knowledge, familiarity, and attitudes towards AI and ethical considerations of AI in medicine. Chi square tests were used and $p<0.05$ was considered to be statistically significant.

RESULTS

The study surveyed a diverse group of medical students, with the majority aged 21–23 years (35%) and slightly more females (55%). Most were in their 3rd or 4th year of study. (Table-1).

Most participants are moderately familiar with AI (40%) and 60% have attended an AI seminar. AI is widely recognized for its applications in medical imaging (85%) and diagnostics (80%). Confidence in AI varies, with the majority rating their confidence level as 3 out of 5 (40%). There were no statistically significant differences in familiarity or seminar attendance (p=0.475). (Table-2).

The majority of participants perceived that AI could potentially improve patient outcomes (75%, p=0.0006), reflecting their understanding of AI's clinical potential rather than any direct observation, as the respondents were medical students, not practising clinicians. Students' views on AI ethics were assessed using a structured Likert-scale questionnaire, where they rated the importance of AI ethics education. Half (50%) rated training on AI ethics as 'very important' (p=0.0001), highlighting strong recognition of ethical literacy as essential to responsible medical practice. The significance values were derived using the Chi-square test, comparing categorical variables to determine associations between AI familiarity, ethics awareness, and perceived outcomes. Key ethical concerns included data privacy (85%) and accountability for AI errors (80%), whereas only 20% believed AI should play a direct role in clinical decision-making (p=0.0000). Slightly over half (55%) had encountered AI ethics in their education, but this finding was not statistically significant (p=0.317). (Table-3).

The majority of participants did not believe that AI will replace doctors (85%, p=0.000). Improved accuracy in diagnosis is seen as the most significant advantage of AI (50%). Ethical concerns (40%) and privacy issues (30%) are the top personal concerns regarding AI. Most participants view the overall impact of AI on healthcare as somewhat positive (60%, p=0.000). (Table-4).

Table-1: Demographics of study participants

Category	Sub-category	Percentage
Age Group (years)	1–20	25
	21–23	35
	24–26	20
	27–29	15
	30 and above	5
Gender	Male	45
	Female	55
Year of Study	1st Year	10
	2nd Year	20
	3rd Year	30
	4th Year	25
	5th Year	15

Table-2: Knowledge about AI in medicine

Category	Sub-category	Percentage	p
Familiarity with AI	Not familiar	10	0.475
	Slightly familiar	30	
	Moderately familiar	40	
	Very familiar	20	
Attended AI Seminar	Yes	60	0.475
	No	40	
Areas AI can be Applied	Diagnostics	80	
	Treatment planning	70	
	Personalized medicine	60	
	Medical imaging	85	
	Administrative tasks	50	
	Other	10	
Confidence in AI Applications (1-5)	1 (Not confident at all)	5	
	2	15	
	3	40	
	4	25	
	5 (Very confident)	15	

Table-3: Ethical implications of AI in medicine

Category	Sub-category	Percentage	p
Believe AI improves patient outcomes	Yes	75	0.0006*
	No	25	
Main ethical concerns	Data privacy & security	85	
	Bias in AI algorithms	70	
	Job displacement	55	
	Accountability for AI errors	80	
	Other	5	
AI role in clinical decisions	Yes	20	0.0000*
	No	65	
	Maybe	15	
Importance of training on AI ethics	Not important	15	0.0001*
	Moderately important	35	
	Very important	50	
Encountered AI ethics in education	Yes	55	0.317
	No	45	

Table-4: Personal opinions and future perspectives

Category	Sub-category	Percentage	p
AI Replacing Doctors	Yes	15	0.000*
	No	85	
Significant Advantage of AI	Improved accuracy in diagnosis	50	
	Faster data processing	25	
	Reduction in human error	15	
	Cost efficiency	10	
Personal Concerns about AI	Ethical concerns	40	
	Privacy issues	30	
	Dependence on technology	20	
	Loss of jobs	25	
	Lack of personal interaction	15	
	Other	5	
Overall Impact of AI on Healthcare	Negative	15	0.000*
	Neutral	25	
	Somewhat positive	60	

DISCUSSION

The findings of this study provide valuable insights into the current level of awareness and perceptions of AI among medical students. The statistics indicate that 40% of the students are quite familiar with AI, and 20% of them self-report that they are very familiar. This is consistent with results by Al Saad *et al*[11], who noted that 47% of students were generally aware of AI and 68.4% thought that AI training must be mandatory among medical students. The increasing interest can be observed, as 60% of the respondents in our survey were present at an AI seminar, which supports the rationale behind the necessity of further studies on the 10% who stated that they were unaware of AI.

In terms of application fields, medical imaging (85%) and diagnostics (80%) were found to be the most significant fields where AI can be utilized, followed by treatment planning (70%) and personalised medicine (60%). These results concur with the literature, as the study by Park *et al*[12] highlighted the promise of AI in transforming medical imaging and diagnosis. Nonetheless, enthusiasm regarding the abilities of AI should be tempered with prudence, as the study by Pinto dos Santos D *et al*[13], reported that AI's promise is exaggerated, and its real-world applications are limited.

Confidence levels in AI applications were moderate among participants (40%), which is similar to findings by Pinto dos Santos D *et al*[13], where students acknowledged AI's potential but expressed concerns about data privacy and reliability. In our study, 75% agreed that AI enhances patient outcomes, echoing Ahmed *et al*[4], who found that 76.7% of respondents supported integrating AI into medical curricula for its promise in improving healthcare outcomes.

Ethical issues are a significant concern, with 85% of our students being concerned with data privacy and 80% with accountability for AI mistakes. These results are in line with those of the Chan *et al*[14] study, which also reported similar concerns among clinicians regarding the ethical implications of AI in clinical practice. The need for training on AI ethics is further underscored by the fact that 50% of students in our study find it very important, supporting Park *et al*[12] and Chan and Zary[14], who stressed that medical education should include both technical and ethical dimensions of AI for responsible clinical use.

Majority of students said they were taught AI ethics reflecting integration of AI-related learning materials into medical education. Nevertheless, the insignificant p=0.317 indicates that exposure is not consistent among the institutions. This result is consistent with Pinto dos Santos D *et al*[13] as well as with the findings of other researchers in the recent past like Roy *et al*[15] who highlighted the fact that medical students would prefer more formal and systematic education on AI and its ethical aspects. Only 15% of respondents believed AI could replace doctors, whereas 85% disagreed (p=0.000). This is in line with Roy E *et al*[15], who stressed that AI should supplement human clinical judgment among aspiring doctors, and Pinto dos Santos D *et al*[13], who found that students see AI as a tool rather than a replacement for clinicians.

Students found some key benefits of AI, most notably in increasing diagnostic accuracy (50%) and accelerating data processing (25%). But these advantages are balanced by worries regarding ethical concerns (40%) and privacy (30%), which indicate a guarded optimism regarding AI's potential in healthcare. Overall, the attitude towards AI's influence on healthcare is largely positive, with 60% of students perceiving it as somewhat positive. This suggests that despite concerns, students generally acknowledge AI's revolutionary potential in improving healthcare outcomes.

The study had strength that the sample was quite representative of all years of medical study. Structured questionnaire was used to ensure consistency in data collection. However, the information is self-reported and can be biased and the sample is restricted to a single institution which may have implications on the generalizability to other medical schools or regions.

CONCLUSION

Medical students are aware of the role of AI in medicine, specifically in diagnostics and imaging, but have serious ethical concerns. AI is considered as an assistant, not a replacement for physicians. There is need to improve AI education as part of medical curricula in order to balance its advantages and ethical issues.

REFERENCES

1. Mehta N, Harish V, Bilimoria K, Morgado F, Ginsburg S, Law M, *et al*. Knowledge of and attitudes on artificial intelligence in healthcare: a provincial survey study of medical students. Medrxiv 2021;2021: DOI: https://doi.org/10.1101/2021.01.14.21249830.
2. Weidener L, Fischer M. Artificial intelligence in medicine: cross-sectional study among medical students on application, education, and ethical aspects. JMIR Med Educ 2024;10:e51247.
3. Jha N, Shankar PR, Al-Betar MA, Mukhia R, Hada K, Palaian S. Undergraduate medical students' and interns' knowledge and perception of artificial intelligence in medicine. Adv Med Educ Pract 2022;13:927–37.
4. Ahmed Z, Bhinder KK, Tariq A, Tahir MJ, Mehmood Q, Tabassum MS, *et al*. Knowledge, attitude, and practice of artificial intelligence among doctors and medical students in Pakistan: A cross-sectional online survey. Ann Med Surg (Lond) 2022;76:103493.
5. Swed S, Alibrahim H, Elkalagi NKH, Nasif MN, Rais MA, Nashwan AJ, *et al*. Knowledge, attitude, and practice of artificial intelligence among doctors and medical students in Syria: a cross-sectional online survey. Front Artif Intell 2022;5:1011524.
6. Buabbas AJ, Miskin B, Alnaqi AA, Ayed AK, Shehab AA, Syed-Abdul S, *et al*. Investigating students' perceptions towards artificial intelligence in medical education. Healthcare (Basel) 2023;11(9:1298.
7. Grunhut J, Marques O, Wyatt AT. Needs, challenges, and applications of artificial intelligence in medical education curriculum. JMIR Med Educ 2022;8(2):e35587.
8. Jackson P, Ponath Sukumaran G, Babu C, Tony MC, Jack DS, Reshma VR, *et al*. Artificial intelligence in medical education-perception among medical students. BMC Med Educ 2024;24(1):804.
9. Allam AH, Eltewacy NK, Alabdallat YJ, Owais TA, Salman S, Ebada MA. Knowledge, attitude, and perception of Arab medical students towards artificial intelligence in medicine and radiology: A multi-national cross-sectional study. Eur Radiol 2024;34(7):1–14.
10. Elhassan SE, Sajid MR, Syed AM, Fathima SA, Khan BS, Tamim H. Assessing familiarity, usage patterns, and attitudes of medical students toward ChatGPT and other chat-based AI apps in medical education: Cross-sectional questionnaire study. JMIR Med Educ 2025;11:e63065.
11. Al Saad MM, Shehadeh A, Alanazi S, Alenezi M, Abu alez A, Eid H, *et al*. Medical students' knowledge and attitude towards artificial intelligence: an online survey. Open Public Health J 2022;15:e2203290.
12. Park SH, Do KH, Kim S, Park JH, Lim YS. What should medical students know about artificial intelligence in medicine? J Educ Eval Health Prof 2019;16:18.
13. Pinto dos Santos D, Giese D, Brodehl S, Chon SH, Staab W, Kleinert R, *et al*. Medical students' attitude towards artificial intelligence: a multicentre survey. Eur Radiol 2019;29(4):1640–6.
14. Chan KS, Zary N. Applications and challenges of implementing artificial intelligence in medical education: Integrative review. JMIR Med Educ 2019;5(1):e13930.
15. Roy E, Malafa S, Adwer LM, Tabache H, Sheth T, Mishra V, *et al*. Artificial Intelligence in healthcare: Medical students' perspectives on balancing innovation, ethics, and patient-centered care. Int J Med Stud 2025;13(1):9–16.

Address for Correspondence:

Dr Aakash Kumar, Department of Surgery, Jinnah Postgraduate Medical Centre, Karachi, Pakistan. **Cell:** +92-331-2515974
Email: akashladkani@gmail.com

Received: **Reviewed:** **Accepted:**

Contribution of Authors:

QAZ: Study concept, critical review and supervision
SR: Study design, methodology and final review
RR: Data analysis result interpretation
NF: Data collection and manuscript writing
AM: Literature review and discussion drafting
AK: Data entry, manuscript drafting and correspondence

Conflict of interest: None **Funding:** None