Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/dp2d4308

ARTIFICIAL INTELLIGENCE, ITS KNOWLEDGE, ATTITUDE, AND PERCEPTIONS AMONG FUTURE HEALTH CARE WORKFORCE - UNDERGRADUATES IN A GOVERNMENT MEDICAL COLLEGE

Swarnalata Garapati[1], Dr. Sridevi Garapati[2], Dr. Sujatha Peetala[3], Dr. Rambabu Rampatruni[4]

[1]Associate Professor, Dept. of Computer Science and Engineering, Rajamahendri Institute of Engineering and Technology, Rajahmundry, Andhra Pradesh,
[2]Associate Professor, Dept. of Community Medicine, Rangaraya Medical college, Kakinada, Andhra Pradesh,
[3]Professor and Head, Dept. of Community Medicine, Rangaraya Medical college, Kakinada, Andhra Pradesh,
[4]Professor and Head, Dept. of Computer Science and Engineering, Rajamahendri Institute of Engineering and Technology, Rajahmundry, Andhra Pradesh, India.

ABSTRACT

Introduction: Artificial Intelligence (AI) has emerged as Metamorphosis in the field of medicine, having the potential to revolutionize diagnostics, treatment, and healthcare delivery. To be ready for new roles and tasks, medical students will need to understand the fundamentals of AI. Knowledge, attitude, and perceptions of AI among undergraduate medical students is crucial, as they represent the future healthcare workforce. **Objectives:** 1. To assess the knowledge of AI concepts and its applications among undergraduate medical students. 2. To know the attitude and perceptions of medical students towards AI in medicine. **Materials and Methods:** Cross-sectional online survey was conducted among undergraduate medical students in Rangaraya Medical college, Kakinada, Andhra Pradesh using semi-structured questionnaire between October and December 2023. The questionnaire was designed to assess their knowledge, attitude towards AI in healthcare, and perceptions about AI's impact on the medical profession. Data was collected from clinical year medical students who gave consent and willing to participate in the study. Analysis done by Microsoft Excel 2010 & SPSS Version 21. Data analysis involved descriptive statistics, chi-square tests to identify factors associated with AI knowledge, attitudes, and perceptions. **Results:** A total of 220 medical students participated, most of them (63.8%) were females. Mean age of the participants was 21±0.84yrs. Of these, most of the students (85.5%) knew about AI whereas 54.1% do not know the application of AI in medicine. In addition, 45% of students agreed that AI will reduce errors in diagnosis, 52.8 – 67.7% agreed that AI is essential in both pathological and radiological diagnostic techniques. More than 1/3rd (39.5%) agreed to include AI in the medical curriculum. However, 58% of the students expressed the fear of replacement of doctor with AI. Furthermore, most of them perceived that AI being subjected to loss of data privacy (75.2%), cyber security attacks (85.8%) and less human interaction with the patient (93.1%). In the present study significant difference was observed with Gender in relation to AI related knowledge ($P<0.05$) and Attitude ($P<0.05$) and study participants knowledge was significantly affecting their attitude towards AI ($P<0.05$). **Conclusion:** Majority of medical students had basic knowledge of AI but need a more in-depth understanding. They had a positive view of AI in the field of medicine and were willing to adopt it, indicating a need

for AI education in the medical curriculum. While they recognize AI's potential to enhance healthcare, they remain cautious about its ability to replace human skills in certain tasks and have concerns about job prospects and ethical implications. Hence, it is crucial to familiarize medical students with AI concepts and ideas so that they can implement such tools for the benefit of patients in the future.

Keywords: Knowledge, attitude, perceptions, undergraduates, and artificial intelligence.

INTRODUCTION

The theory and development of computer systems that can do activities that ordinarily require human intellect, such as speech recognition, visual perception, decision-making, and language translation, are referred to as artificial intelligence (AI) [1]. AI is the simulation or combination of machine learning and deep learning, the application of which results in deliberate outcomes [2,3]. In general, AI refers to the concept of automated machines able to perform human tasks [4]. This indicates that AI functions similarly to humans but not exactly as humans do; this function is still in development [2,3]. Furthermore, the use of AI is pervasive and primarily focuses on numerous disciplines in all industries [2,3]. However, the emerging uses of AI attracting a great deal of attention in Medicine and Dentistry over the past decade [5]. The field of medicine and healthcare stands on the precipice of a revolutionary transformation due to the immense potential of artificial intelligence (AI). AI is involved in many aspects of the healthcare industry, including patient record-keeping, medical diagnosis, surgical assistance, and treatment. It has already started to impact on specialties such as radiology [6], pathology [7] and dermatology [8] especially in the developed world. Many earlier studies reported that AI is found to have multiple roles in healthcare, for example, AI in improving human decision-making and efficiency; the role of AI in disease conditions, such as radiology, neurosurgical imaging, skin lesions, tumors, chest pain, neurological diseases such as Alzheimer's disease, and also in the diagnosis of breast cancer; drug discovery; therapy selection, especially in patients with comorbid conditions and on multiple treatments [2,3,9-11]. Several studies internationally revealed that AI has a positive impact on their profession or their workflow [11,12].

Many countries have already adopted the usage of AI [2,3,12-14], with the United States, Australia, Canada, and the Chinese healthcare systems [14–18] being among them. In Canada, a recent study among healthcare students revealed that students projected that AI technology would have an impact on their jobs within the next decade and expressed optimism about the emerging role of AI in their particular disciplines [17]. AI attitudes differed by discipline [17]. Even students who were hostile toward AI recognized the importance of incorporating a rudimentary understanding of AI into their curricula [17]. AI integration in healthcare and education has seen widespread acceptance in high-income countries (HICs), as evidenced by a 2020 survey of medical students in the United Kingdom, which revealed generally positive attitudes and perceptions toward AI's incorporation into medical curricula. On the other hand, the Chinese State Council has issued a guideline on AI development, indicating that the widespread use of AI will raise the level of precision in medical services and attain intelligent medical care [18]. Additionally, AI continues to play an integral role in shaping the way medical students and future healthcare professionals interact within the healthcare ecosystem. Evidence exists that AI solutions offer a new horizon of possibilities for learning and higher education, particularly for medical and nursing students [19]. In Saudi Arabia, a recent survey conducted across the country revealed that 7% of Saudi radiology residents used artificial intelligence in their daily work [2], which indicates that the use of AI in various aspects of healthcare will become more widespread in the future. Therefore, knowledge and perceptions about AI and machine learning (ML) help for when AI comes into use, since professionals will be using them soon, and they are expected to play an important role in their clinical workflow. AI is not commonly addressed during undergraduate medical education [20], as the medical educators and schools are still unsure about the precise evolving role of the physician in relation to AI, which makes it difficult to develop instructional strategies [21]. A lack of knowledge among healthcare professionals regarding AI and

ML may translate into poorer patient outcomes due to a lack of understanding about selecting tools that add value and integrating these into patient care. It is important to note that the utilization of AI in healthcare remains relatively unexplored, under-researched, and underfunded, particularly in low- and middle-income countries [22]. By improving diagnostic precision and treatment appropriateness, the use of AI in health care can revolutionize the way doctors practice [23]. Since AI will be used soon and is anticipated to play a significant part in healthcare workflow, having skills in AI and machine learning (ML) would be helpful. As a result, care must be taken in educating the next generation of physicians, as they will require advanced clinical practices, which can be performed with the help of AI applications. Therefore, this study focuses on determining awareness, attitudes, and perceptions towards artificial intelligence among undergraduate medical students.

MATERIALS AND METHODS

A cross-sectional descriptive (web based) study was conducted at Rangaraya Medical College, East Godavari district, Andhra Pradesh between October, and December 2023. All medical students who were in the third professional year were included in the study. The sample population was selected using a convenience sampling technique, a total of 220 students were participated in the study. Data were collected in the form of online survey questionnaire which covered the domains of knowledge, attitudes and perceptions related to AI. The first section collected demographic and background information about the participants gender and knowledge - to test the extent of familiarity of the students with important terms relating to AI in healthcare. The second section included questions answered using the Likert scale. Attitude questions were designed based on a 5-point Likert scale. The scale used options ranging from 1, "strongly disagree," to 5, "strongly agree," with 3 being "neutral". The third section of the study aimed to understand students' perceptions. Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 21. A descriptive analysis was used to estimate frequencies, and the chi-square test was utilized to determine the statistical association between variables. Results with a p-value of <0.05 considered as statistically significant.

Ethical considerations: "Ethics and Scientific Committees" granted the approval of the study through the proposal "Knowledge, Attitude, And Perceptions of Artificial Intelligence Among Undergraduate Medical Students in a Government Medical College: A Cross-Sectional Study" (REG.NO:IEC/RMC/2023/1058). The purpose of the study was clearly defined, and the participants were provided with informed online consent and participation was entirely voluntary.

RESULTS:

A total of 220 undergraduate medical students have been participated in the web-based study. The mean age of the study participants was 21.01 ± 0.84years. Of them Males were 36.2% and females 63.8%.

Knowledge of Medical Students about Artificial Intelligence (AI):

In the first part of this study, we explored the knowledge of the medical students about artificial intelligence. Regarding knowledge of AI, individuals were questioned about the basic concept of AI, its sub types i.e., machine learning (ML), deep learning (DL), and its applications (Figure1).

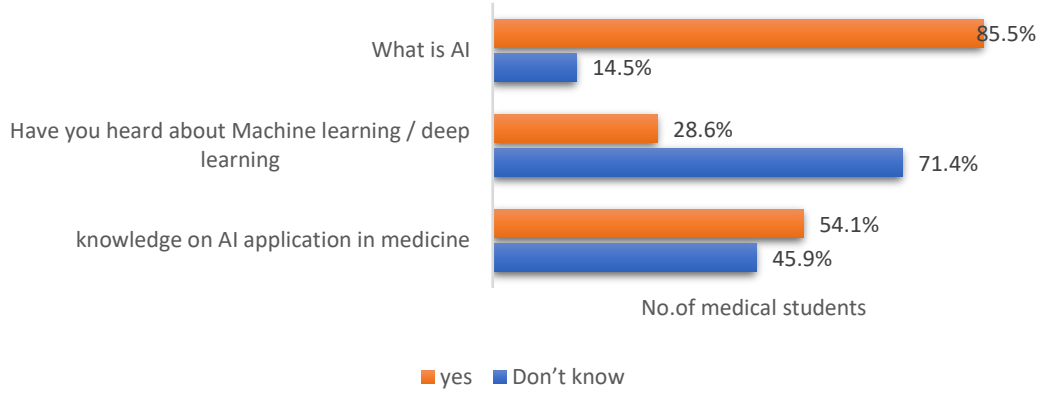

Fig: 1 Knowledge of AI among medical students

It was observed that 85.5% had a basic concept about AI but only 28.6% had knowledge about ML and DL. However more than half of them (54.1%) had knowledge about its applications. Gender has significantly affecting the knowledge of AI ($P < 0.05$). Females were found to have more knowledge about AI than males. But there was no significant difference in gender regarding knowledge related to machine learning and application of AI in medicine ($P > 0.05$).

Different sources of knowledge for AI among the medical students was found to be social media (56%), web browsing (30%), friends & family (10%) followed by books and others (4%) shown in fig:2

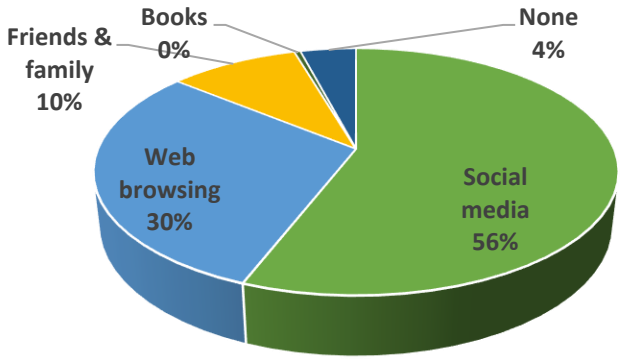

Fig: 2 Sources of information on AI among medical students

Attitude of medical Students towards Artificial Intelligence (AI):

Fig:3 Presents participants' responses to the attitude items. This sub-scale has nine questions about the attitude of medical students toward AI. Each statement of the main variables in the questionnaire corresponds to a list that carries the following choices according to Likert's five-point scale: strongly agree, agree, neutral, disagree, and strongly disagree. Each of these choices was given grades to be statistically processed as follows: strongly agree, five (5) grades; agree, four (4) grades; neutral, three (3) grades; disagree, two (2) grades; and strongly disagree, one (1). Necessity of AI in the medical field was agreed by 11.5 -34.4%, AI can reduce errors in medical diagnosis was agreed by 45.0%. Whereas 39.4% had neutral attitude. Most of them (52.8 -67.7%) agreed that AI had its role in both pathological & radiological diagnostic techniques. Only few (10.1%) participants disagreed the need of AI in times of pandemic such as COVID – 19. Positive attitude in incorporation of AI in medical curriculum was observed to be 10.6-28.9%. AI as medical practitioners aid was agreed by 39.9% and, they had fear of AI as burden & replacement of a doctor in future by AI was strongly agreed by 18.4-

39.6%. Nearly half (41%) of the study participants agreed that there is a need for budget allocation for promotion and implementation of AI in health sector.

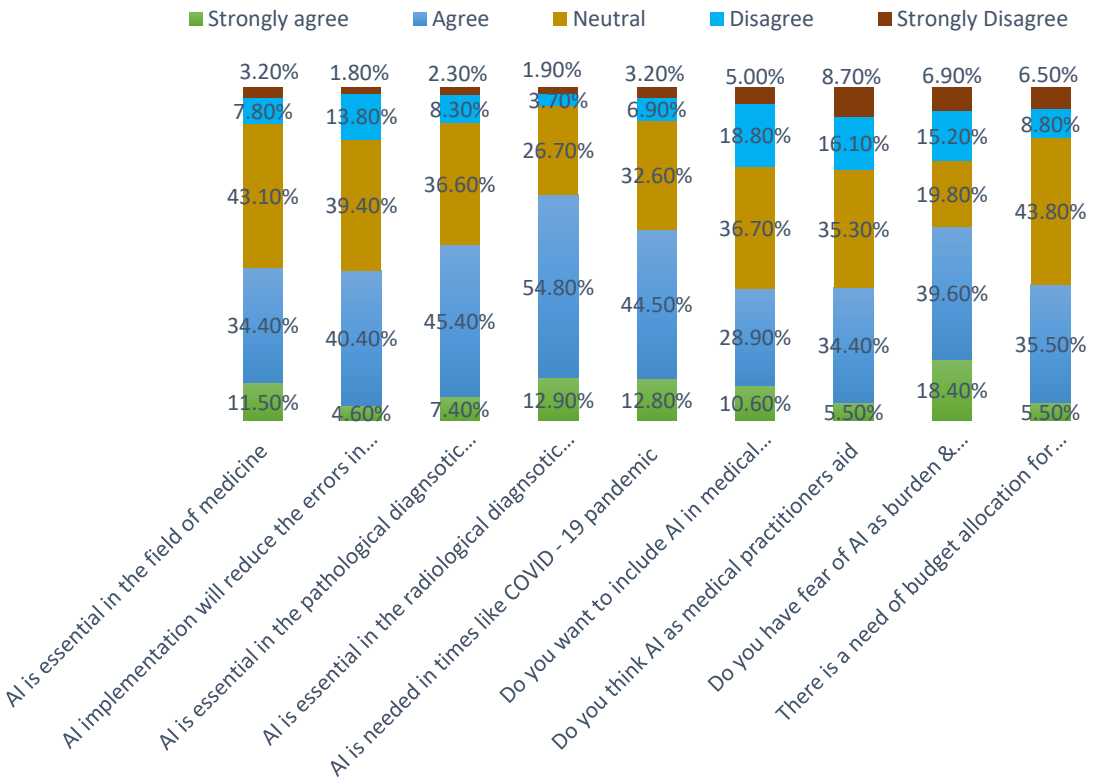

Fig: 3 Attitude of medical students towards AI

From fig:4 and 5 statistically significant association $p<0.05$ was observed with female gender to certain attitude variables; Essentiality of AI in radiological ($p<0.001$) and pathological diagnostic techniques ($p=0.04$), need for budget allocation for implementation of AI in health sector ($p=0.02$) and fear of AI being burden and replacing the doctor ($p=0.02$). Knowledge related to AI has significant association with students attitude towards the essentiality of AI in pathological diagnostic techniques ($p=0.02$) and need of AI being incorporation in medical curriculum ($p<0.05$).

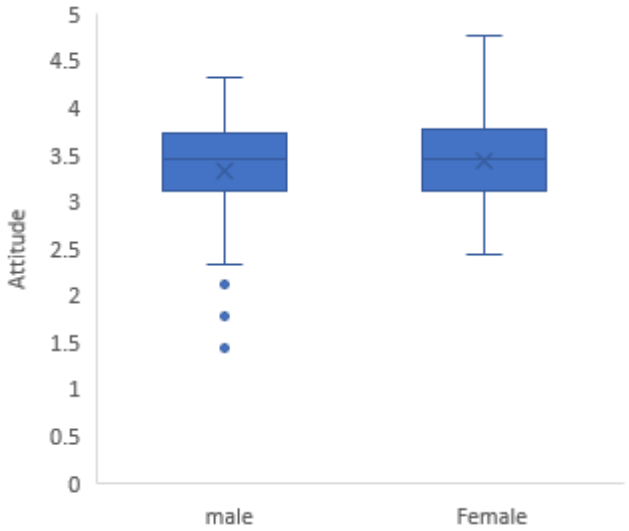

Fig:4 Gender and Attitude

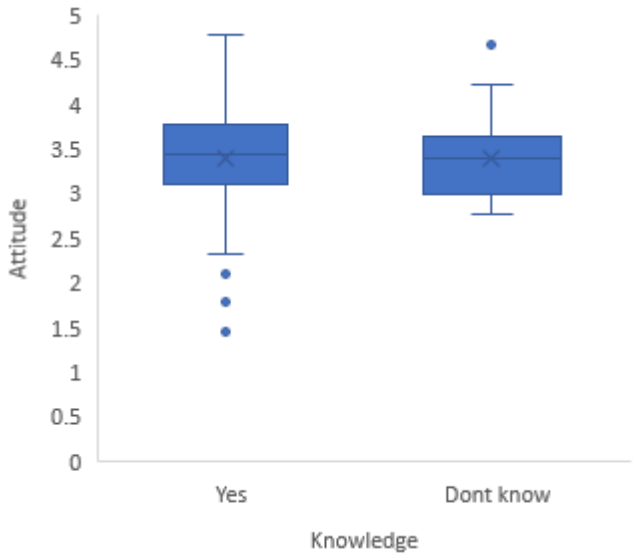

Fig:5 Knowledge and Attitude

Perceptions of medical Students towards Artificial Intelligence (AI) (fig:6):
It was observed that medical students had good perceptions towards AI: more than two thirds of medical students believed that enhanced or automated medical diagnosis and disease prognosis would be possible with AI (67.9 -68.3%), AI enhances patient workflow (60.1%) and AI will enhance medical education (76.6%). Conversely, the main concerns on the utilization of AI were less human interaction with the patient was expressed by 93.1%, sensitive data leakage including cyber security attacks in 85.8% and fear of replacement of doctor by 66.8% of the medical students.

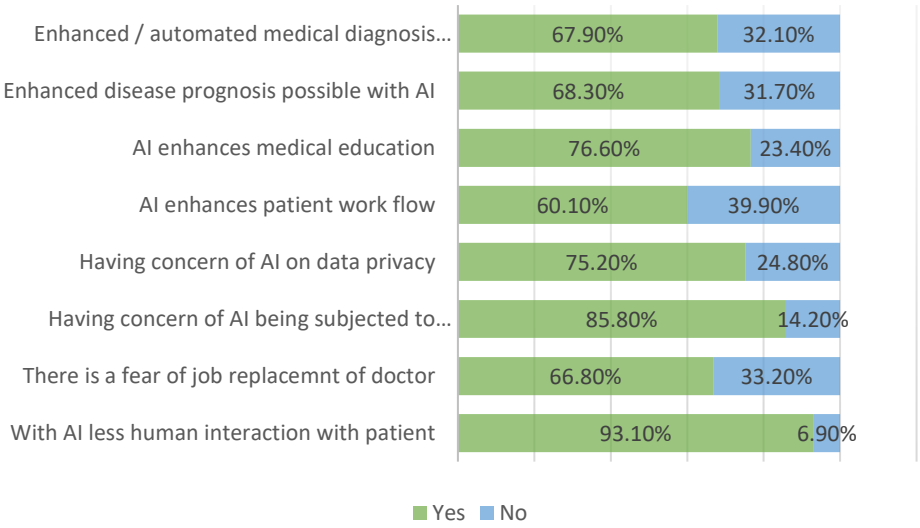

Fig:6 Perceptions of medical students towards AI

DISCUSSION:
This study aimed to explore medical students' knowledge, attitude, and perceptions, regarding the role of AI in the healthcare sector.

Knowledge
In the present study majority (85.5%) of study participants were familiar with the term "artificial intelligence" and more than half (54.1%) knew about role of AI in health sector, while only a subset

(28.6%) familiar with the term "machine learning / deep learning." These results suggest that students have some basic knowledge of AI but need a more in-depth understanding. A similar trend was seen in a study conducted in Nepal, Pakistan, and Saudi Arabia [20,24,25]. A study among medical students showed that 50% of the students agreed that they have a good understanding of AI [16], whereas a study on dental students in Saudi Arabia concluded that only 44.2% were aware of the usage of AI in dentistry [26], while a study in Canada among healthcare students concluded that 51.08% were not aware of AI [17]. Source of information about AI among the study participants was found to be social media (56%), web browsing (30%) followed by family & friends (10%). Similar findings were observed in a multinational and multi-center survey conducted among medical and dental students where the main source of knowledge related to AI was social media (59.4%) and web browsing (60.1%) [27]. Recent research has also explored medical students' attitudes and knowledge of AI in healthcare, where medical students had a positive outlook toward AI in healthcare but needed to gain significant knowledge on the subject [28]. This result is in line with the findings of the current study. However, gender showed significant difference in knowledge related to AI ($p<0.05$). Similar findings were observed in studies conducted by Zinah, A et al [29] and Ahmed, Z et al [30]. This tells us that giving lectures on AI impacts the student's overall knowledge.

Attitude

In the present study attitude towards AI among medical students was found to be good. Nearly half of the students agreed or strongly agreed that artificial intelligence reduces errors in medical practice (45%), another recent study from a developing country by Ahmed et al in 2022 revealed that 3.2% of students and 6.3% of health care professionals (HCPs) strongly agreed and 27.1% of students and 30% of doctors agreed that AI implementation reduces the errors in diagnosis and treatment, while 2.4% of students and 4% of healthcare professionals strongly disagreed and 27.9% of students and 33.6% of healthcare professionals disagreed regarding the contribution of AI in reducing medical errors [30]. While in a study conducted among pharmacy students in Saudi Arabia 75% of the students agreed or strongly agreed that artificial intelligence reduces errors in medical practice [25]. In this study 18.4% medical students strongly agreed that AI as burden and will replace a doctor in future. Similar results were observed in a study by Syed W et al in Saudi Arabia, 17.8% of the students believed that artificial intelligence replaces the physician, pharmacist, or nurse in the healthcare system [25]; Jha et al.'s study revealed that over half the respondents agreed that AI would reduce the number of jobs for healthcare professionals [20]. AI as medical practitioners aid agreed to strongly agreed by 34.4 – 5.4% of the study participants, whereas Ahmed et al. in 2022 revealed that approximately 70% of medical students and 81.8% of doctors from the study population acknowledged that AI could serve as a practitioner's aid soon, and most of them did not consider AI as a physician's replacement but rather a physician's diagnostic aid [30]. Regarding the inclusion of AI in the medical curriculum,39.5% of students agreed to include knowledge and skills about AI where as in a study among pharmacy students 56.7% of the students agreed to include in pharmacy curriculum while 61.8% of the students agreed to include a simplified lecture on artificial intelligence, computer use, coding, and Python language [25]. Ahmed et al also concluded that 74% of medical students and 83% of physicians agreed to include it in the school curriculum [30]. In the present study most of the medical students agreed that AI is essential in pathological (52.8%), radiological diagnostic techniques (67.7%) and in times of COVID-19 (57.3%). Similar findings were observed in a study conducted among doctors and medical students in Pakistan where 64.9% acknowledged AI necessity in radiology, while 59.8% agreed with its use in pathology and the COVID-19 pandemic, respectively [30,31]. Similarly, another study reported that 91.5% of students in the United States agreed that training in artificial intelligence during medical school would be useful for their future, while 79.4% were excited to use artificial intelligence technologies [32]. Furthermore, most students regarded it as essential to include it in the college curriculum and also use studies, seminars, or residency training as the best way to educate students about the use of AI in healthcare. In the present

study gender exhibits significant difference in their attitude towards AI ($p<0.05$), Swed S et al reported similar findings in a cross sectional study conducted among medical students of Syria [31].

Perception

The findings of this study provide insight into medical students' perceptions of the potential impact of AI on healthcare. The findings of this study reported that 60.1% of study participants perceived that AI enhances patients work flow. In a similar study conducted in Saudi Arabia 23% agreed that AI reduces the workforce [25]. These findings were in contrast to previous findings published by Jha et al., where the author reported that 24.1% of medical students and doctors disagreed about AI reducing the workforce [20]. There is a fear of job replacement of doctor by AI among study participants (66.8%). Whereas in a study among pharmacy students, majority (69.4%) believed AI is a tool that helps HCPs rather than replaces HCPs in the healthcare system [25]. This perception is consistent with the findings of a study by Ahmed et al., which reported that healthcare professionals perceived radiology and pathology as the medical specialties most likely to be impacted by AI, as they concluded that the potential influence of AI on these specializations is because they involve the interpretation of medical imagery, a job that AI can accomplish with accuracy and speed [30]. In fact, tasks such as medical management requires a combination of clinical judgment, empathy, and communication skills, which are challenging to replicate through AI technologies. The findings further suggest that AI may have a role in assisting clinicians in these tasks rather than fully replacing them. This perception aligns with previous studies where Zhang et al. reported that healthcare professionals were concerned about job loss due to AI and perceived AI as a technology that would replace humans in certain tasks [33]. The study also investigated the students' perceptions regarding the timeline for AI technologies to excel healthcare professionals in certain tasks, which varied widely. This finding agrees with previous studies that have suggested that AI is most likely to take over healthcare workers in tasks that include data analysis [34]. These findings are consistent with the results of other studies that have shown that AI algorithms can achieve higher accuracy and efficiency in certain clinical tasks compared to healthcare professionals [34]. In this study, most of the medical students (76.6%) perceived that AI enhances medical education. Similarly in a study conducted among pharmacy students appeared to have good perceptions and opinions about AI and its benefits in healthcare. More than half (57.3%) of the students believed that AI would make the healthcare profession better [25]. This finding is consistent with the growing recognition of the importance of AI education in healthcare, as AI is increasingly used in clinical decision-making and patient care [35]. It is a fact that rapid advances in the field of technology will certainly change the practice of HCPs, as routine tasks can be performed faster and more efficiently with the aid of AI. Teng et al., from their study confirmed that AI would have positive impact on their careers [17]. In the present study most of the students expressed the concern of AI on data privacy (75.2%) and of AI being subjected to hacking /cyber security attacks (85.8%). Study also expressed the fear of less human interaction with AI (93.1%). Similar perception was observed in a multi-centre survey conducted among medical and dental students [27]. This suggests that medical students recognize the importance of the human touch in certain areas of healthcare, where empathy and emotional intelligence are essential components of care. Need of separate budget allocation for promotion and implementation of AI in health sector was perceived by 41%which was similar from the study by Ahmed et al (48.7%) [30].

Conclusions:

The findings of this study highlight several important insights into the knowledge, attitudes, and perceptions of medical students regarding artificial intelligence (AI). It is evident that a significant majority of students lack a solid understanding of AI basics, Concepts such as deep learning/machine learning and a notable gap in their understanding of its applications in health care. Attitudes towards AI were generally positive, with students recognizing its potential to improve patient care and diagnostic accuracy. However, concerns regarding job security, data privacy and less human

interaction were also prevalent. This suggests a considerable gap in formal education or training in the field of AI among medical students. Incorporation of AI into medical curriculum to bridge knowledge gaps and prepare future healthcare professionals for the AI-driven healthcare landscape were recommended.

Limitations:
This study included clinical-year medical students from only one medical college, and hence, this means that the study's results might not be generalizable to other populations, other universities, or to medical students in their earlier years of study. Moreover, the study is based on a self-administered questionnaire. As with any self-reported data, there is a potential for bias, including recall bias, social desirability bias, or misunderstanding questions. Also the survey was voluntary, self-selection bias might have occurred, and it is conceivable that only the students who were interested in AI and medical technology responded.

Ethical considerations:
Institutional ethical committee clearance obtained.

Acknowledgments:
We thank all study participants for their voluntary participation and for providing essential information

Conflicts of Interest:
None declared.

Bibliography:
1. Oxford English Dictionary. Artificial Intelligence. Available online: https://www.oed.com/viewdictionaryentry/Entry/27 1625.
2. Mirza, A.A.; Wazgar, O.M.; Almaghrabi, A.A.; Ghandour, R.M.; Alenizi, S.A.; Mirza, A.A.; Alraddadi, K.S.; Al-Adwani, F.H.; Alsakkaf, M.A.; Aljuaid, S.M. The Use of Artificial Intelligence in Medical Imaging: A Nationwide Pilot Survey of Trainees in Saudi Arabia. Clin. Pract. 2022, 12, 852–866. [CrossRef] [PubMed]
3. Ting, D.S.W.; Pasquale, L.R.; Peng, L.; Campbell, J.P.; Lee, A.Y.; Raman, R.; Tan, G.S.W.; Schmetterer, L.; Keane, P.A.; Wong, T.Y. Artificial intelligence, and deep learning in ophthalmology. Br. J. Ophthalmol. 2019, 103, 167–175. [CrossRef]
4. Amisha, Malik P, Pathania M, Rathaur VK. Overview of artificial intelligence in medicine. J Fam Med Primary Care. (2019) 8:2328–31. doi: 10.4103/jfmpc.jfmpc_440_19
5. Carlos RC, Kahn CE, Halabi S. Data science: big data, machine learning, and artificial intelligence. J Am College Radiol. (2018) 15:497–8. doi: 10.1016/j.jacr.2018.01.029
6. Hosny A, Parmar C, Quackenbush J, Schwartz LH, Aerts HJWL. Artificial intelligence in radiology. Nat Rev Cancer. (2018) 18:500 10. doi: 10.1038/s41568-018-0016-5
7. Chang HY, Jung CK, Woo JI, Lee S, Cho J, Kim SW, et al. Artificial intelligence in pathology. J Pathol Transl Med. (2019) 53:1–12. doi: 10.4132/jptm.2018.12.16
8. Du-Harpur X, Watt FM, Luscombe NM, Lynch MD. What is AI? Applications of artificial intelligence to dermatology. Br J Dermatol. (2020) 183:423 30. doi: 10.1111/bjd.18880
9. Miotto R, Wang F, Wang S, Jiang X, Dudley JT. Deep learning for healthcare: Review, opportunities, and challenges. Brief Bioinf. 2018, 19, 1236–1246. [CrossRef] [PubMed]
10. Esteva A, Robicquet A, Ramsundar B, Kuleshov V, DePristo M, Chou K, Cui C, Corrado G, Thrun S, Dean J. A guide to deep learning in healthcare. Nat. Med. 2019, 25, 24–29. [CrossRef]
11. Kermany D.S, Goldbaum M, Cai W, Valentim C.C.S, Liang H, Baxter S.L, McKeown A, Yang G, Wu X, Yan F et al. Identifying Medical Diagnoses and Treatable Diseases by Image-Based Deep Learning. Cell 2018, 172, 1122–1131.e9. [CrossRef]

12. Tang A, Tam R, Cadrin-Chênevert A, Guest W, Chong J, Barfett J, Chepelev L, Cairns R, Mitchell J.R, Cicero, M.D.; et al. Canadian Association of Radiologists White Paper on Artificial Intelligence in Radiology. Can. Assoc. Radiol. J. 2018, 69, 120–135. [CrossRef]
13. Webster C.S. Artificial intelligence and the adoption of new technology in medical education. Med. Educ. 2021, 55, 6–7. [CrossRef]
14. Chen M, Zhang B, Cai Z, Seery S, Gonzalez MJ, Ali NM, Ren R, Qiao Y, Xue P, Jiangs Y. Acceptance of clinical artificial intelligence among physicians and medical students: A systematic review with cross-sectional survey. Front. Med. 2022, 9, 990604. [CrossRef]
15. Global Australia. Artificial Intelligence (AI). Available online: https://www.globalaustralia.gov.au/industries/digitech/artificial intelligence.
16. Kassam A, Kassam N. Artificial intelligence in healthcare: A Canadian context. In Healthcare Management Forum; SAGE Publications: Sage, CA, USA; Los Angeles, CA, USA, 2020; Volume 33, pp. 5–9, No. 1.
17. Teng M, Singla R, Yau O, Lamoureux D, Gupta A, Hu Z, Hu R, Aissiou A, Eaton S, Hamm C et al. Health Care Students' Perspectives on Artificial Intelligence: Countrywide Survey in Canada. JMIR Med. Educ. 2022, 8, e33390. [CrossRef]
18. Li R, Yang Y, Wu S, Huang K, Chen W, Liu, Y.; Lin, H. Using artificial intelligence to improve medical services in China. Ann. Transl. Med. 2020, 8, 711. [CrossRef]
19. Sapci AH, Sapci HA. Artificial intelligence education and tools for medical and health informatics students: Systematic review. JMIR Med Educ [Internet]. 2020;6(1): e19285. Available from: http://dx.doi.org/10.2196/19285
20. 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 Ed Pract 2022;13:927-37.
21. Singh RP, Hom GL, Abramoff MD, Campbell JP, Chiang MF. Current challenges and barriers to real-world artificial intelligence adoption for the healthcare system, provider, and the patient. Trans Vis Sci Technol 2020;9:45. doi: 10.1167/tvst. 9.2.45.
22. Kazi AM, Qazi SA, Ahsan N, Khawaja S, Sameen F, Saqib M, Khan Mughal MA, Wajidali Z, Ali S, Ahmed RM, Kalimuddin H, Rauf Y, Mahmood F, Zafar S, Abbasi TA, Khoumbati KUR, Abbasi MA, Stergioulas LK. Current Challenges of Digital Health Interventions in Pakistan: Mixed Methods Analysis. Journal of Medical Internet Research. 2020;22(9).
23. Bohr A, Memarzadeh K. The rise of artificial intelligence in healthcare applications. Art Int Health 2020;14:25-60. doi: 10.1016/B978-0-12-818438-7.00002-2.
24. Abid S, Awan B, Ismail T, et al.: Artificial intelligence: medical students' attitude in district Peshawar Pakistan. PJPH. 2019, 9:19-21. 10.32413/pjph.v9i1.295
25. Syed W, Basil A. Al-Rawi, M. Assessment of Awareness, Perceptions, and Opinions towards Artificial Intelligence among Healthcare Students in Riyadh, Saudi Arabia. Medicina 2023, 59, 828. https://doi.org/10.3390/ medicina59050828
26. Khanagar, S.; Alkathiri, M.; Alhamlan, R.; Alyami, K.; Alhejazi, M.; Alghamdi, A. Knowledge, attitudes, and perceptions of dental students towards artificial intelligence in Riyadh, Saudi Arabia. Med. Sci. 2021, 25, 1857–1867.
27. Bisdas S, Topriceanu C-C, Zakrzewska Z, Irimia A-V, Shakallis L, Subhash J, Casapu M-M, Leon-Rojas J, Pinto dos Santos D, Andrews DM, Zeicu C, Bouhuwaish AM, Lestari AN, Abu-Ismail L, Sadiq AS, Khamees A, Mohammed KMG, Williams E, Omran AI, Ismail DYA and Ebrahim EH (2021) Artificial Intelligence in Medicine: A Multinational Multi-Center Survey on the Medical and Dental Students' Perception. Front. Public Health 9:795284. doi: 10.3389/fpubh.2021.795284
28. Mousavi Baigi SF, Sarbaz M, Ghaddaripouri K, Ghaddaripouri M, Mousavi AS, Kimiafar K: Attitudes, knowledge, and skills towards artificial intelligence among healthcare students: a systematic review. Health Sci Rep. 2023, 6:e1138. 10.1002/hsr2.1138

29. Al Hadithy Z A, Al Lawati A, Al-Zadjali R, et al. (September 08, 2023) Knowledge, Attitudes, and Perceptions of Artificial Intelligence in Healthcare Among Medical Students at Sultan Qaboos University. Cureus 15(9): e44887. DOI 10.7759/cureus.44887
30. Ahmed, Z.; Bhinder, K.K.; Tariq, A.; Tahir, M.J.; Mehmood, Q.; Tabassum, M.S.; Malik, M.; Aslam, S.; Asghar, M.S.; Yousaf, Z. Knowledge, attitude, and practice of artificial intelligence among doctors and medical students in Pakistan: A cross-sectional online survey. Ann. Med. Surg. 2022, 76, 103493. [CrossRef]
31. Swed S, Alibrahim H, Elkalagi NKH, Nasif MN, Rais MA, Nashwan AJ, Aljabali A, Elsayed M, Sawaf B, Albuni MK, Battikh E, Elsharif LAM, Ahmed SMA, Ahmed EMS, Othman ZA, Alsaleh A and Shoib S (2022) Knowledge, attitude, and practice of artificial intelligence among doctors and medical students in Syria: A cross sectional online survey. Front. Artif. Intell. 5:1011524.doi:10.3389/frai.2022.1011524
32. Liu, D.S.; Sawyer, J.; Luna, A.; Aoun, J.; Wang, J.; Boachie, L.; Halabi, S.; Joe, B. Perceptions of US Medical Students on Artificial Intelligence in Medicine: Mixed Methods Survey Study. JMIR Med. Educ. 2022, 8, e38325. [CrossRef]
33. Zhang Y, Luo M, Wu P, Wu S, Lee TY, Bai C: Application of computational biology and artificial intelligence in drug design. Int J Mol Sci. 2022, 23:10.3390/ijms232113568
34. Patel S: Aspects of artificial intelligence. Learning Outcomes of Classroom Research. Karthikeyan J, Hie TS, Jin NY (ed): L' Ordine Nuovo Publication, New Delhi; 2021. 48-55.
35. Topol EJ: High-performance medicine: the convergence of human and artificial intelligence. Nat Med. 2019, 25:44-56.