'Medical Minds and Machine Learning': Awareness and Opinions on Artificial Intelligence in Healthcare among Undergraduate Medical Students of a Tertiary Care Institute of Kolkata, India

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Abstract:

Introduction: There is a need to incorporate Artificial Intelligence (AI) in medical education which may help in expanding awareness on role of AI in healthcare among the students. **Objectives:** To assess the awareness and opinions on role of AI in healthcare among undergraduate medical students of a Tertiary Care Institute of Kolkata and to identify any associated sociodemographic factors with their awareness on AI. **Method:** Descriptive study was conducted using consecutive sampling among 288 undergraduate medical students using a pretested questionnaire, from August - October (2023). Participants with an 'overall awareness score on AI' equal to or above median were categorized as having 'high awareness'. Association of sociodemographic profile with awareness was assessed using binary logistic regression. **Results:** Almost half (51%) of the students belonged to Phase III of MBBS. Around 70.8% believed AI will reduce medication errors, while 83.3% opined AI will aid in healthcare-oriented research. 53.5% had low awareness on role of AI. Higher odds of low awareness were found among students whose parents were involved in healthcare. **Conclusion:** Almost half of the students had high awareness on role of AI in healthcare. More seminars, workshops etc., may be helpful in generating further awareness and orientation among the undergraduate medical students for appropriate use of AI applications in future.

Keywords: Artificial Intelligence, Awareness, Machine Learning, Medical education

Introduction:

Artificial Intelligence (AI) means making machines capable of simulating intelligence by giving the computer human-like capabilities, such as understanding, reasoning and problem-solving. AI interprets external data, learns from it, and uses this learning to achieve specific goals and tasks.[1] AI systems can perform numerous functions to provide support to clinicians in various medical fields, such as drug development, disease diagnostics; health monitoring, medical data management, personalized medicine; and in the analysis of health plans, surgical treatments, and medical treatments.[1,2] They may detect things that are comparable to what they know and label them accordingly.[2] This provides a human-like experience, yet it is only a simulation. The AI may not understand commands, but it will respond to them using algorithms.[3] When a powerful AI is

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confronted with a problem, it proceeds to solve it without the need for human participation.[4]

AI, which is also referred to as machine intelligence, is commonly used when a machine mimics cognitive behaviour associated with the human brain during learning and problem solving.[4] Nowadays, biological and chemical scientists extensively incorporate AI algorithms in drug designing and discovery process. Computational modelling based on AI and Machine Learning (ML) principles provides a great avenue for identification and validation of chemical compounds, target identification, peptide synthesis, evaluation of drug toxicity and physiochemical properties, drug monitoring, drug efficacy and effectiveness, and drug repositioning.[5] Artificial Neural Networks (ANN) and Deep Learning (DL) algorithms have modernized the area.[5,6]

With the development of neural networks, machines could classify and organize inputted data that mimics like a human brain, which further shows advancement in AI.[6] Deep Learning (DL) is a subset of ML, which itself is a subset of AI, and thus, the evolution goes like AI>ML>DL. ML either uses supervised learning, where the model is trained to use labelled data, which means that the input has been tagged with corresponding preferred output labels or uses unsupervised learning.[7]

AI subsets of machine learning and deep learning also plays an important role in the medical education of undergraduate medical students and trainees in post-graduate programs.[8] AI program has multiple challenges for the implementation in the health sector including provider's inertia, financial restrictions, limitation of trained health professionals for setting up diagnostic protocols on which algorithms are based, lack of data on public perception and implications of AI, and fear of replacement of physician, social barriers, confidentiality, and medicolegal implications.[8,9]

Developing countries like India are lagging in the implementation of AI-based solutions in healthcare.[10] It is hypothesized that the undergraduate medical students are not fully aware of the AI implications in medicine and other sectors of healthcare and research. Therefore, with this background in mind, the current study was undertaken among the undergraduate medical students of a Tertiary Care Teaching Institute of Kolkata, India.

Method:

Study design, and study setting: The study had a cross-sectional design, and was conducted among undergraduate medical students of Institute of Post Graduate Medical Education and Research (IPGME&R) and Seth Sukhlal Karnani Memorial (SSKM) Hospital, Kolkata.

Study duration and study participants: The study was conducted for a period of 3 months (August 2023 to October 2023). The study participants included all the undergraduate medical students from Phase I to Phase III (Part I and Part II) of the MBBS curriculum.

Inclusion and Exclusion criteria: The study included all undergraduate medical students from Phase I to Phase III (Part I and Part II) who were present during their lecture classes and/or clinical postings during the data collection period. The study excluded all those medical students who were pursuing their compulsory rotatory internship during the phase of the study and those who did not give informed written consent for participation in the study were excluded.

Sample size and sampling technique: The total number of undergraduate medical students (Phase I to Phase III of MBBS) in IPGME&R and SSKM Hospital are 750. Hence, the expected sample size at the beginning of conduction of the study was estimated to be 750. However, after applying the selection criteria, the final sample size at the end of the data collection period turned out to be 288. Consecutive sampling technique was employed to achieve the desired sample size.

Study tools and study technique: An anonymous, predesigned, pretested and structured questionnaire was employed to obtain data from the eligible study participants. It contained a mixture of open-ended and semi-open, single and multiple-response questions and was developed in English language, since the medical students were well-versed in English. The questionnaire collected data across the domains of sociodemographic characteristics of the study participants, their awareness and opinions regarding the role of AI in healthcare. The awareness domain included 11 items, e.g.- AI devalues the medical profession, AI reduces errors in medical practice, AI facilitates patients access to the service, AI facilitates healthcare professionals access to information, AI enables healthcare professionals to make more accurate decisions, AI increases patients confidence in medicine, etc. The opinion domain included total 7 items, like- Knowledge and skill development in AI should be included in the undergraduate medical curriculum, Proper training should be required to prevent and solve ethical issues that may arise with AI tools and applications, A simplified lecture on AI, Computer use, Coding, Python language should be included in the undergraduate medical curriculum should be included, AI applications is needed to aid in scientific research in future. This self-administered questionnaire was validated using content validity and face validity by three respected faculties from the Medical Education Unit (MEU) of the institution and necessary changes were incorporated before pretesting it. Pretesting of the questionnaire was done on 28 undergraduate medical students belonging to the institution, who were later excluded from the final sample. The students who attended their clinical postings/lecture classes during the data collection period and fulfilled the eligibility criteria, were consecutively administered the questionnaire at the end of their classes or postings, while those who were absent at the time of data collection, were called over the telephone and told to come the next day. Four phone calls were made individually for those who were absent during data collection. Those who did not reply or were absent during their lecture classes/clinical postings throughout the data collection period were excluded from the study. Data were collected for three randomly selected days in a week. Thus, at the end of the data collection period, which continued for 1.5 months, the final sample size turned out to be 288.

Study variables*:* Independent variables in the study were the sociodemographic characteristics of the study participants. Dependent variables included the awareness and opinions of the eligible participants on the role of AI in healthcare.

Statistical analysis: Data were tabulated in Microsoft Office Excel 2021 and analysed using the Statistical Package for the Social Sciences (SPSS) version 25.0. (Armonk, NY: IBM Corp. 2017). Descriptive analyses were represented using Mean (± SD), frequency and percentage and with the help of appropriate diagrams. Awareness on role of AI in healthcare was assessed using 11 items on a 5-point Likert Scale, ranging from Strongly agree (score of 4) to Strongly disagree (score of 0). Thus, the total possible score ranged from 0-44. The item 1 and items from 8-11 in the awareness domain were reversely scored. An overall scoring of awareness was done, followed by categorization of awareness based on the median of the overall awareness score. Those who scored more than and equal to the median of the overall awareness score were categorized as having high awareness while score less than the overall median score was categorized as having low awareness. Median of the overall awareness score was employed for categorization as the data distribution was not normal (skewed distribution). There was a total of 7 items which assessed the opinions of the students on the role of AI in healthcare. Results for the opinion domain was based on descriptive statistics. Multivariable Binary

Logistic Regression analyses was performed to identify any associations between the sociodemographic characteristics of the study subjects with their awareness on AI. All the variables having a p-value less than 0.2 in the univariate logistic regression analyses were considered biologically plausible and included in the multivariable model to check for model fitness, after checking for multi-co-linearity (variance inflation factor more than 10 and tolerance less than 0.1). A p-value of less than 0.05 at 95% Confidence Interval (CI) was considered as statistically significant.

Ethical considerations: Proposal of the study was submitted, and ethical clearance was obtained from the Institutional Ethics Committee (IEC) of IPGME&R and SSKM Hospital, Kolkata (*IPGME&R/IEC/2023/976*). Informed written consent were taken from the study participants. Anonymity and confidentiality of data were maintained throughout the study.

Results:

The mean age of the study participants was 21.2 (± 3.7) years. Majority of them belonged to the age-group of 21-24 years (73.6%). Out of the total participants, 214 (74.3%) were males, nearly half [149 (51.7%)] of the students belonged to Phase III of MBBS, 178 (61.8%) were currently residing in the institutional hostel, 100 (34.7%) of the students passed XIIth standard under the CBSE Board (Central Board of Secondary Education), while the remaining under the WBCHSE (West Bengal Council of Higher Secondary Education) or ISC (Indian School Certificate) Board. Regarding the occupational status of the participants parents, the mothers of 196 (68.1%) participants and fathers of 200 (69.5%) participants were employed. Among the participants, 35 (12.2%) of them had their parents involved in healthcare profession (doctors, nurses, paramedics, etc.). (Table 1).

Nearly 76% of the students have not received

Table1: Socio-demographic characteristics of study participants (N=288)

Socio-Demographic Characteristics	n (%)
Age (in completed years)	
17–20	7 (2.4)
21–24	69 (24.0)
≥ 25	212 (73.6)
Gender	
Female	74 (25.7)
Male	214 (74.3)
Phase of MBBS	
Phase I	90 (31.2)
Phase II	49 (17.1)
Phase III (Part I)	111 (38.5)
Phase III (Part II)	38 (13.2)
Current residential status	
Hosteler	178 (61.8)
Day scholar	90 (31.2)
Rented house/Paying guest	20 (7.0)
Board in which passed XIIth standard	
WBCHSE	154 (53.5)
CBSE	100 (34.7)
ISCE	23 (8.0)
Other state boards	11 (3.8)
Education of mother	
Illiterate	4 (1.4)
Primary	13 (4.5)
Middle school	26 (9.0)
Secondary	34 (11.8)
Higher secondary	48 (16.7)
Graduate and above	163 (56.6)
Occupation of mother	
Employed	196 (68.1)
Unemployed	38 (13.2)
Others (housewives and retirees)	54 (18.7)
Education of father	
Primary	9 (3.1)
Middle school	10 (3.5)
Secondary	21 (7.3)
Higher secondary	36 (12.5)
Graduates and above	212 (73.6)
Occupation of father	
Employed	200 (69.5)
Unemployed	30 (10.4)
Retirees	58 (20.1)
Any parent involved in healthcare	
Yes	35 (12.2)
No	253 (87.8)

Figure 1: Distribution of study participants based on their responses if AI applications become widespread in India in future (N= 288)

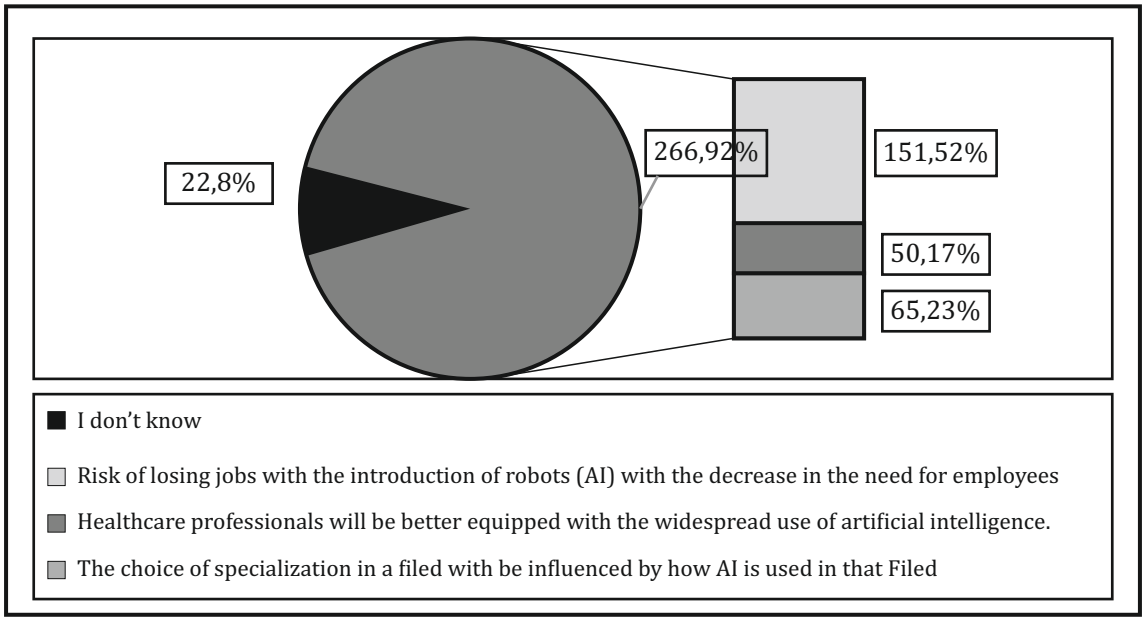

Table 2: Distribution of study participants according to their responses (awareness) on role of AI in healthcare (N= 288)

Questions	Strongly agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Strongly disagree n (%)
"AI devalues the medical profession."	19 (6.6)	54 (18.7)	90 (31.2)	101 (35.1)	24 (8.4)
"AI reduces errors in medical practice."	28 (9.7)	184 (63.8)	57 (19.8)	15 (5.2)	4 (1.4)
"AI facilitates patients access to the service."	32 (11.2)	158 (54.8)	71 (24.6)	24 (8.4)	3 (1.0)
"AI facilitates healthcare professionals access to information."	41 (14.2)	177 (61.4)	46 (15.9)	12 (4.1)	12 (4.1)
"AI enables healthcare professionals to make more accurate decisions."	30 (10.4)	159 (55.2)	62 (21.5)	24 (8.4)	13 (4.5)
"AI increases patients confidence in medicine."	18 (6.2)	91 (31.6)	98 (34.1)	71 (24.6)	10 (3.5)
"AI facilitates patient education."	18 (6.2)	126 (43.7)	91 (31.6)	46 (15.9)	7 (2.4)
"AI negatively affects the relationship between healthcare professionals and the patient."	22 (7.6)	112 (38.9)	82 (28.5)	61 (21.2)	11 (3.8)
"AI damages the trust of the patient on the healthcare professional."	26 (9.1)	115 (39.9)	89 (30.9)	50 (17.4)	8 (2.7)
"AI reduces the humanistic aspect of the medical profession."	51 (17.7)	123 (42.7)	54 (18.7)	53 (18.4)	7 (2.4)
"Use of AI may result in violations of professional confidentiality."	19 (6.6)	139 (48.2)	97 (33.7)	29 (10.1)	4 (1.4)

any formal education on AI. Almost 35% of the students disagreed to the fact that AI devalues medical profession, while 63.9% agreed that AI reduces errors in medical practice. Around 54% patients agreed that AI facilitates patients access to healthcare services. Nearly 55% agreed that AI enables healthcare professionals to make more accurate decisions, 38.9% believed that AI negatively affects the doctor-patient relationship. Nearly 40% of the participants also agreed that AI destroys the trust built upon the healthcare professionals by the patients. (Table 2) Among the study subjects, 154 (53.5%) had low awareness whereas 134 (46.5%) had high awareness on the role of AI in healthcare.

The study participants were of the opinion that knowledge and skills in AI is required for better implementation of treatment strategies (76.7%), while 70.8% opined AI will reduce errors in medical practice. Nearly 77% opined that a simplified lecture on AI and its tools, coding, cloud computing, application of Python software, etc. should be executed in medical colleges and 83.3% opined that AI will also aid in scientific research. Almost 62% were of the opinion that AI will assist in dealing with emergency responses in the upcoming times. (Table 3). 73% of the study subjects opined that healthcare professionals will be better equipped if AI applications become more widespread in India. (Figure 1)

Multivariable Binary Logistic Regression analyses of awareness of study participants on the role of AI in healthcare were performed with their sociodemographic characteristics. The results revealed statistically significant higher odds of low awareness among the students whose parents were involved in healthcare (aOR= 2.50, 95% CI 1.38-5.07; p 0.005) as compared to students whose parents were not involved in healthcare, while lower odds of low awareness (aOR= 0.31, 95% CI 0.15-0.65; p 0.002) on AI were observed among the students belonging to the Phase III of MBBS (Part I) as compared to other undergraduate students belonging to others phases of MBBS. The model fitness information was given by the Omnibus Test of Model Coefficients, which was statistically significant, (p=0.01) and by the Hosmer-Lemeshow Goodness of Fit Test which was not statistically significant (p =0.97). These findings suggested a good fit of the model. (Table 4)

Table 3: Students' opinions on role of AI in healthcare (N= 288)

Questions	Yes n (%)	No n (%)	Not sure n (%)
Knowledge and skill development in AI should be included in the undergraduate medical curriculum	221 (76.7)	25 (8.7)	42 (14.5)
AI should be used as an application for reducing medication errors	204 (70.8)	13 (4.5)	71 (24.7)
Proper training should be required to prevent and solve ethical issues that may arise with AI tools and applications	212 (73.6)	19 (6.6)	57 (19.8)
A simplified lecture on AI, Computer use, Coding, Python language should be included in the undergraduate medical curriculum should be included	222 (77.1)	24 (8.3)	42 (14.6)
Knowledge and skill development on AI applications should be included to increase patients control over their health	171 (59.4)	27 (9.4)	90 (31.2)
AI applications is needed to aid in scientific research in future	240 (83.4)	14 (4.8)	34 (11.8)
Knowledge and skills on AI are needed to help assist in emergency responses	177 (61.4)	26 (9.1)	85 (29.5)

Table 4: Multivariable Binary Logistic Regression showing the association of socio-demographic characteristics of study participants with their awareness on the role of AI in healthcare (N=288)

Socio-demographic characteristics	Low awareness on role of AI (n1= 154)		
	n (%)	aOR (95% CI)	p-value
Age of study participants (in completed years)			
17-20	47 (30.5)	0.58 (0.25-1.02)	0.051
21-24	103 (66.9)	0.73 (0.14-4.16)	0.777
≥ 25	4 (2.6 %)	Ref.	-
Gender of participants			
Females	117 (76.0)	1.86 (0.48-2.53)	0.621
Males	37 (24.0)	Ref.	-
Phase of MBBS			
Phase I	54 (35.1)	0.57 (0.25-1.29)	0.962
Phase II	28 (18.2)	0.87 (0.44-1.77)	0.918
Phase III (Part I)	72 (46.7)	0.31 (0.15-0.65)	0.002
Phase III (Part II)	0 (0)	Ref.	-
Involvement of parents in healthcare			
Yes	18 (11.7)	2.50 (1.38-5.07)	0.005
No	136 (88.3)	Ref.	-

(Ref. Cat= 'High awareness' on role of AI in healthcare)

Model fitness: *Cox and Snell R-square=0.07, Nagelkerke R-square=0.10, Omnibus Test was significant (p=0.01) but Hosmer-Lemeshow Test was not significant (p=0.97) (Statistically significant values highlighted in bold text)*

Discussion:

In a study conducted by Syed W et al.[11] most of the students (73.9%) knew about AI. In addition, 69.4% of the students thought that AI is a tool that helps healthcare professionals (HCP). 57.3% of the students were aware that AI would assist healthcare professionals in becoming better with the widespread use of AI. The mean score was significantly associated with age (p = 0.030), year of study (p = 0.040), and nationality (p = 0.013). The gender of the participants was found to have no significant association with the mean positive perception score (p = 0.916). On the contrary, the results from the current study revealed that 53.5% had high awareness on the role of AI. 76.7% of the students opined knowledge and skills in AI is the need of the hour, 70.8% believed AI will reduce medication, while 83.3% opined AI will aid in healthcare-oriented research. Higher odds of high awareness were found among the students whose parents were involved in healthcare (aOR= 2.50, 95% CI 1.38-5.07; p 0.005).

A study conducted by Park SH et al.[12] in 2024, examined the effectiveness of a pilot Digital Health Scholars (DHS) non-credit enrichment elective that paralleled the Dartmouth Geisel School of Medicine's first-year preclinical curriculum with a focus on introducing AI algorithms. Ten self-selected first-year students enrolled in the elective curriculum. The study demonstrates that a digital health enrichment elective that runs in parallel to an institution's preclinical curriculum and embeds AI concepts into relevant clinical topics can enhance students' confidence in describing the content objectives that pertain to high-level algorithmic understanding. This is in contrast to the current study, which was conducted on undergraduate medical students of a Tertiary Care Institute in Eastern India, where it was found that 51% belonged to Phase III of MBBS and

74.3% were males. 53.5% had high awareness on the role of AI. 76.7% of the students opined knowledge and skills in AI is the need of the hour, 70.8% believed AI will reduce medication, while 83.3% opined AI will aid in healthcare-oriented research. Higher odds of high awareness were found among the students whose parents were involved in healthcare (aOR= 2.50, 95% CI 1.38-5.07; p 0.005). This study mainly focused on the students awareness on AI and their opinions on the role of AI in healthcare. Also, nearly 15% believed that AI will replace the healthcare professionals in near future.

Another study done by Maine B et al.[13] in India in 2021, medical curriculum should be focussed on AI literacy rather than expertise. AI researchers/data scientists may act as resource persons to conduct faculty development programs in AI for medical faculty. For the medical students, emphasis should be laid on population health and evidence-based medicine. The present study too, emphasized on the fact that medical students from the grassroot level should have a formal training of using AI tools to spot anomalies, forecast patterns from medical data and make decisions.

In a study conducted by Randhawa GK et al.[14] in Canada, despite the rich and early history of AI in medical education, its application in the education of healthcare professionals in Canada has generally been limited. The current study also focussed on the issue that a developing country like India still needs to expand the domain of AI in healthcare and for that purpose, AI awareness and its judicious application should be included in the undergraduate medical education curriculum, clubbed with workshops and seminars on the importance of AI in healthcare. In general, there is a paucity of literature on the knowledge and attitudes of the medical students regarding AI, especially interprofessional education and the continuing professional development of healthcare professionals.

According to Narayana S et al.[15] in a study done in 2023, AI tools can aid the researcher in collecting relevant research articles, identifying the knowledge gaps in the literature, formulating research questions, recommending appropriate statistical methods for the available data, creating a graphical representation of the data, and manuscript writing. In contrast to this study, the current study explored the awareness and opinions on AI in healthcare among undergraduate medical students, to identify the lacunae in their understanding and awareness of the same and implement corrective measures so that the future doctors of our country can be better equipped with AI technology and tools.

A study conducted by Daher OA et al.[16] in Lebanon, there is a notable awareness of AI among students who are eager to learn about it. Despite this interest, there exists a gap in knowledge regarding DL, alongside a positive attitude towards it. Additionally, a higher percentage of students from Mount Lebanon (71.6%) showed an inclination towards using AI compared to Beirut (63.2%) (p=0.03). Noteworthy are the Lebanese University and Saint Joseph University, where the highest proportions of students are willing to integrate AI into the medical field (79.4% and 76.7%, respectively; p=0.001). The present study revealed that 51% of undergraduate medical students belonged to Phase III of MBBS and 53.5% had high awareness on the role of AI. 76.7% of the students opined knowledge and skills in AI is the need of the hour, 70.8% believed AI will reduce medication, while 83.3% opined AI will aid in healthcare-oriented research in upcoming times, but nearly 15% believed that AI will replace the healthcare professionals in the near future.

A review article done by Mir MM et al.[17] high-quality data that met the study objectives were included. The goal of this review article was to present the implications of AI in medical education, now and in the coming years. On the contrary, the results from the current study revealed that 53.5% had high awareness on the role of AI. 76.7% of the students opined knowledge and skills in AI is the need of the hour, 70.8% believed AI will reduce medication, while 83.3% opined AI will aid in

healthcare-oriented research. Higher odds of high awareness were found among the students whose parents were involved in healthcare (aOR= 2.50, 95% CI 1.38-5.07; p 0.005). The aim of the present study was to assessing the awareness and opinions on role of AI in healthcare among undergraduate medical students of a Tertiary Care Institute of Kolkata and to identify any associated sociodemographic factors with their awareness on AI.

Limitations of the study:

The current study was conducted in one tertiary care institute; hence it may not represent the overall awareness and opinions of undergraduate students, particularly of those belonging to other peripheral medical colleges of the state. Also, the study relied upon self-reported data, which may be subjected to social desirability bias.

Conclusion:

The results from this study revealed that more than half of the students had low awareness on role of AI in healthcare, majority of students recognized the potential of AI in reducing medication errors and advancing healthcare-oriented research. Workshops and seminars on various AI tools and applications of AI in healthcare and research should be conducted in the medical colleges all over the country, for generating more awareness and creating an insight into the role of AI among the medical students, so that ethical and judicious use of AI applications can be implemented by the future doctors of our country.

Declaration:

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Conflicts of interest: Nil

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