**Original Article :**

# Knowledge, Perceptions, and Practice of Artificial Intelligence among Medical Students and Doctors at King Faisal University, Saudi Arabia.

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**Abstract**

**Background and Aims:**
Artificial Intelligence is no longer a new concept for the medical profession but is still finding its way into the realm of healthcare. Saudi Arabia is attempting to make most of it, especially in major healthcare settings.

**Methods:**
A cross-sectional survey was conducted at King Faisal University using a self-administered questionnaire assessing sociodemographic characteristics as well as knowledge, perceptions, and practice of AI. Universal sampling was implemented to recruit all medical students in the clinical stage of MBBS (Bachelors of Medicine and Surgery) and all available doctors working at KFU. Descriptive analysis and a chi-squared test was applied for determining correlation of sociodemographic variables with outcome variables, i.e., knowledge, perceptions, and practices relating to AI.

**Results:**
A total of 159 participants participated in our study. Those who were being taught about AI had significantly more basic knowledge about it (96.9%) than those not being taught about it (81.1%). Knowledge about deep learning was significantly higher among men (43.9%) than women (16.1%). The majority of the participants strongly agreed (84.4%) that AI is essential in medical practice, and most doctors and students have applied AI in the past in the medical field, are willing to practice it in the future, and/or are considering how to include it in the medical curriculum.

**Conclusions:**
There is a need for rigorous research, education, and focused training of present and future doctors to help them learn the significance of, and acquire the skills to implement, AI as one component of modern technology.

**Keywords:**
artificial intelligence, knowledge, perception and practice, medical professionals.

## Introduction

Artificial Intelligence (AI) in the healthcare profession has gained global attention in recent years and its use is no longer an innovative idea, but the fourth industrial revolution is still finding its way into the realm of healthcare [1]. For decades, AI has been explained broadly as the ability of machines to perform cognitive functions and reasoning, tasks that are generally associated with human brain activity in terms of learning, decision making, and problem solving skills [2].

The AI technology has not only advanced in medicine [3], but has also made remarkable progress in the field of surgery and surgical education and training, which was previously assumed to be a purely human skill for decision making [4, 5]. In decision making about surgical outcomes, artificial intelligence assists with addressing diverse and disorganized sources of information, including data on patients' risk factors and comorbidities, anatomical structures, and natural history of disease based on algorithms, and the costs to be incurred in surgery, as well as assisting both surgeons and patients with making better predictions about the outcome of surgical decision making [5]. In order to stay updated and incorporate AI technology in the surgical field, a nationwide survey was carried out among surgeon members of the Dutch Association, with the majority (85%) agreeing that AI could add value to their surgical work and none being worried about their job replacement due to AI introduction (they were confident enough to build their capacities to adapt these technological advancements) [6].

High-income countries (e.g. USA, China and some of European countries) have invested considerable resources in education and research on the implementation of artificial intelligence, machine learning, and deep learning in the healthcare industry [7]. As far as many developing countries in Africa and Asia are concerned, despite the support of artificial intelligence at the government level, they are still lagging behind in terms of research, education, and the implementation of AI in medical settings [8]. The lack of resources such as skills, expertise, and finances to invest in technologies in resource-constrained settings has been compounded by the COVID-19 pandemic, whereas knowledge and skills about AI and its implementation in healthcare settings can play a pivotal role in reducing diagnostic errors and overall workload, which would result in good clinical outcomes [9].

In previous decades, remarkable development has been observed in artificial intelligence, as further innovative tech-

nologies have evolved such as machine learning (Machine learning is a branch of artificial intelligence (AI) which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy) (ML) and deep learning (Deep learning is a subset of machine learning, which is essentially a neural network with three or more layers) (DL) algorithms, with DL replacing ML from now on [10]. The two subsets of AI, i.e., ML and DL, have both been explored in the healthcare sector, worldwide [11]. In the past, various applications of AI technology algorithm in the medical field have been observed, among which the majority were in the field of radiology, with others such as cardiology, oncology, neurology, pathology, ophthalmology, dermatology, and psychology [12-16]. Several attributes of AI technology implementation have been observed by researchers, such as detection of abnormal characteristics in imaging, interpretation of results, improvements in the predictive properties of existing experimentation testing methods in pathology, and robustness in terms of assessment of ophthalmic abnormalities and benign and malignant pathologies in dermatology [13], [17-21].

Researchers, by hypothesis generation and testing through various studies have identified the need for incorporating AI in the medical curriculum in the form of machine learning and deep learning, the practical subsets of AI, which have a substantial role to play in undergraduate medical education programs and for postgraduate trainees during on-job training in hospitals [22]. Some of the developing countries, despite advocacy and initiative at the government level related to AI applications, are still struggling to embed the technology in the healthcare sector as well as at medical colleges due to financial constraints, limited healthcare professional expertise, a lack of data to develop algorithms, the fear of job replacement, medicolegal implications, social barriers, and the need for confidentiality [22, 23]. Thus, very little is known about AI and its applications among healthcare workers and medical students [24].

The Kingdom of Saudi Arabia, being a rapidly developing country, is in a good position to make the most of AI usage, especially in major healthcare settings. Therefore, this study aimed to determine the readiness of medical professionals to implement AI by assessing the knowledge, perceptions, and practice of AI among medical students and doctors at King Faisal University, Saudi Arabia.

## Methods

*Study design, population and setting:*

A cross-sectional survey was conduct-

ed among medical students at the clinical stage of MBBS and all available doctors working at King Faisal University who consented to take part in the study.

*Sample size estimation*

The sample size of 196 participants was calculated using Open Epi version 3.01 (Open Source Epidemiologic Statistics for Public Health, Version. www.OpenEpi.com). This was based on the proportion of basic knowledge about artificial intelligence found in a previous study, i.e. 85% [6], considering a confidence level of 95% and 5% margin of error

*Sampling technique:*

Non-probability purposive sampling was implemented to recruit all the study participants, who were students or professionals such as consultants, medical graduates, or postgraduate trainees or fellows working at King Faisal University, available at the time of interview, and who provided consent to participate and give information for our research study.

*Study questionnaire*

A study questionnaire was adapted from previous literature [6, 11] that contains information related to sociodemographic characteristics (age and gender), qualification details (year of undergraduate and graduate degrees), knowledge (about artificial intelligence, machine learning, deep learning, and the application of AI in medical practice), perceptions (whether AI is essential or not in medical practice, whether AI should be included in the medical curriculum or not), and practice of AI (ever having applied AI in a medical setting, intention to learn about AI and apply it in a future healthcare setting or not). The questionnaire was administered to undergraduate students, graduate students, and healthcare specialists.

*Data collection and processing*

Questionnaire was shared electronically to the study participants. A web-link was generated for the questionnaire and shared with the potential respondents through WhatsApp group and also via direct messages. Data was compiled in Microsoft Excel (Microsoft Corporation. (2018). Microsoft Excel. Retrieved from https://office.microsoft.com/excel) and then entered into statistical package, i.e. SPSS version 22 (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.) .

*Statistical analysis*

Data were analyzed using SPSS version 22 (IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Descriptive analysis, i.e., frequencies and proportions (%), were determined and after ensuring it meets the assumptions, a chi-squared test was conducted to assess

the distribution of sociodemographic variables in relation to knowledge, perceptions, and practices on AI.

*Ethical Consideration*

The Institutional Review Board (IRB) of King Faisal University provided approval for the study (KFU-REC-2022-MAY-EA000617).

## Results

Approximately 200 undergraduate medical students, medical graduates, and specialists from King Faisal University, KSA were invited to participate, out of which 159 provided consent and completed the study questionnaire—a response rate of around 80%. The reason for nonresponse could be that the study was conducted during the university summer holidays; therefore, the data collection was a challenge.

*Demographic and educational characteristics*

The mean (± SD) age of study participants was 28.9 years (±8.8) years. The majority of study participants were female, i.e., 93 (58.5%), while 66 (41.5%) were male. The majority (64.2%) of the participants were undergraduate students, whereas 11.9% had a fellowship, 9.4% had membership (e.g. MRCP and likes), and 8.8% were medical graduates, followed by postgraduate certification (3.8%), postgraduate diploma (1.3%), and postgraduate trainee (0.6%). Clinical specialty constituted 57 of the total sample, while obstetrics and gynecology specialty was most common, i.e., 28.1%, followed by general surgery (26.3%), internal medicine (24.6%), family medicine (8.8%), family and community medicine (5.2%), public health (5.2%), and one participant from physiology. The mean (± SD) years of experience among specialists was 11.18 (±6.7) (Table 1).

Table 1. Demographic, qualification, and specialty profile of medical students and healthcare professionals at King Faisal University, KSA (n = 159).

| Characteristics | n (%) |
|---|---|
| Age of the participants (Mean ± SD) | 28.9 (±8.8) |
| Gender | |
| Male | 66 (41.5%) |
| Female | 93 (58.5%) |
| Qualification of participants | |
| Undergraduate | 102 (64.2%) |
| Fellowship | 19 (11.9%) |
| Membership | 15 (9.4%) |
| MBBS or equivalent | 14 (8.8%) |
| Postgraduate certificate | 6 (3.8%) |

| Characteristics | n (%) |
|---|---|
| Postgraduate diploma | 2 (1.3%) |
| Postgraduate trainee | 1 (0.6%) |
| Specialty of doctors (n = 57) | |
| Obstetrics and gynecology | 16 (28.1%) |
| General Surgery | 15 (26.3%) |
| Internal Medicine | 14 (24.6%) |
| Family Medicine | 5 (8.8%) |
| Family and Community Medicine (FAMCO) | 3 (5.2%) |
| Public health | 3(5.2%) |
| Physiology | 1 (1.8%) |
| Years of experience of specialists (n = 57) (Mean ± SD) | 11.18 (±6.7) |

*Knowledge about artificial intelligence*

Using Chi-square test ($\chi 2$), we found that, participants who were being taught about AI had more basic knowledge about it (96.9%) than those who were not being taught about it (81.1%), p-value 0.02, and the difference was statistically significant; knowledge about Machine Learning and Deep Learning was also significantly higher among those who were being taught (87.5% and 71.9%, respectively, p-value 0.00) as opposed to those who were not being taught about AI (37% and 16.5%, respectively, p-value 0.00); Those who were taught about AI, 96.9% had knowledge about AI applications in medical practice as compared to 34.6% who were not taught about it, p-value 0.00 (Table 2).

Table 2. Distribution of factors such as knowledge, attitudes, and practice associated with artificial intelligence (AI) among medical students and healthcare professionals at King Faisal University, (n=159)

| Factors | AI taught during medical school/PG training | AI is not taught during medical school/PG training | ***p*-value** |
|---|---|---|---|
| | *n* (%) | *n* (%) | |
| Knowledge about Artificial Intelligence | | | |
| Yes | 31 (96.9%) | 103 (81.1%) | 0.02 |
| No | 1 (3.1%) | 24 (18.9%) | |
| Knowledge about Machine Learning | | | |
| Yes | 28 (87.5%) | 47 (37.0%) | 0.00 |
| No | 4 (12.5%) | 80 (63.0%) | |
| Knowledge about Deep Learning | | | |
| Yes | 23 (71.9%) | 21 (16.5%) | 0.00 |
| No | 9 (28.1%) | 106 (83.5%) | |
| Knowledge about AI applications in medical practice | | | |
| Yes | 31 (96.9%) | 44 (34.6%) | 0.00 |
| No | 1 (3.1%) | 83 (65.4%) | |

| Factors | AI taught during medical school/PG training | AI is not taught during medical school/PG training | ***p*-value** |
|---|---|---|---|
| | *n* (%) | *n* (%) | |
| Ever applied AI in medical practice | | | |
| Yes | 24 (75%) | 16 (12.6%) | 0.00 |
| No | 8 (25%) | 111 (87.4%) | |
| **AI is essential in medical practice | | | |
| Strongly agree | 27 (84.4%) | 48 (37.8%) | 0.00 |
| Agree | 5 (15.6%) | 61 (48.0%) | |
| No opinion | 0 (0%) | 15 (11.8%) | |
| Disagree | 0 (0%) | 3 (2.4%) | |

A significant difference was found in knowledge about deep learning with respect to gender as it was more common among males (43.9%) than females (16.1%) (Table 3). Graduates and post-graduates (94.7%) had more knowledge about AI as compared to undergraduates (78.4%) (p-value = 0.00). **>20% cells have expected count less than 5 so likelihood ratio was used

Table 3. Distribution of factors associated with artificial intelligence (AI) among medical students and healthcare professionals by gender (n = 159).

| Factors | Male | Female | p-value |
|---|---|---|---|
| | n (%) | n (%) | |
| Knowledge about Artificial Intelligence | | | |
| Yes | 59 (89.4%) | 75 (80.6%) | 0.13 |
| No | 7 (10.6%) | 18 (19.4%) | |
| Knowledge about Machine Learning | | | |
| Yes | 36 (54.5%) | 39 (41.9%) | 0.11 |
| No | 30 (45.5%) | 54 (58.1%) | |
| Knowledge about Deep Learning | | | |
| Yes | 29 (43.9%) | 15 (16.1%) | 0.00 |
| No | 37 (56.1%) | 78 (83.9%) | |
| Knowledge about AI applications in medical practice | | | |
| Yes | 34 (51.5%) | 41 (44.1%) | 0.35 |
| No | 32 (48.5%) | 52 (55.9%) | |
| Ever applied AI in medical practice | | | |
| Yes | 21 (31.8%) | 19 (20.4%) | 0.10 |
| No | 45 (68.2%) | 74 (79.6%) | |
| **AI is essential in medical practice | | | |
| Strongly agree | 32 (48.5%) | 43 (46.2%) | 0.07 |
| Agree | 30 (45.5%) | 36 (38.7%) | |
| No opinion | 2 (3.0%) | 13 (14.0%) | |
| Disagree | 2 (3.0%) | 1 (1.1%) | |

*1.1. Attitude and perceptions towards artificial intelligence*

There was a significant difference among participants with respect to their attitude towards AI in that those who were taught about AI strongly agreed (84.4%) or agreed (15.6%) that AI is essential in medical practice as compared to those who were never taught about AI; i.e., 37.8% strongly agreed and 48.0% agreed (p-value = 0.00) (Table 2).

Table 4. Distribution of factors associated with knowledge and practices of artificial intelligence (AI) among medical students and healthcare professionals by qualification (n = 159).

| Factors | Graduate/post graduate | Undergraduate | p-value |
|---|---|---|---|
| | n (%) | n (%) | |
| Knowledge about Artificial Intelligence | | | |
| Yes | 54 (94.7%) | 80 (78.4%) | 0.00 |
| No | 3 (5.3%) | 22 (21.6%) | |
| Knowledge about Machine Learning | | | |
| Yes | 25 (43.9%) | 50 (49.0%) | 0.53 |
| No | 32 (56.1%) | 52 (51.0%) | |
| Knowledge about Deep Learning | | | |
| Yes | 20 (35.1%) | 24 (23.5%) | 0.11 |
| No | 37 (64.9%) | 78 (76.5%) | |
| Knowledge about AI applications in medical practice | | | |
| Yes | 27 (47.4%) | 48 (47.1%) | 0.90 |
| No | 30 (52.6%) | 54 (52.9%) | |
| Ever applied AI in medical practice | | | |
| Yes | 25 (43.9%) | 15 (14.7%) | 0.00 |
| No | 32 (56.1%) | 87 (85.3%) | |
| AI is essential in medical practice | | | |
| Strongly agree | 28 (49.1%) | 47 (46.1%) | 0.03 |
| Agree | 28 (49.1% | 38 (37.3%) | |
| No opinion | 1 (1.8%) | 14 (13.7%) | |
| Disagree | 0 (0%) | 3 (2.9%) | |

Graduates and postgraduates who strongly agreed (49.1%) or agreed (49.1%) that AI is essential in medical practice outnumbered undergraduates who strongly agreed (46.1%) and agreed (37.3%) (Table 4). Of the total graduates and postgraduates, 22 strongly agreed and 32 agreed for the inclusion of AI in the medical curriculum, while undergraduates who strongly agreed and agreed with including AI in the curriculum numbered 37 and 38, respectively (Figure 1).

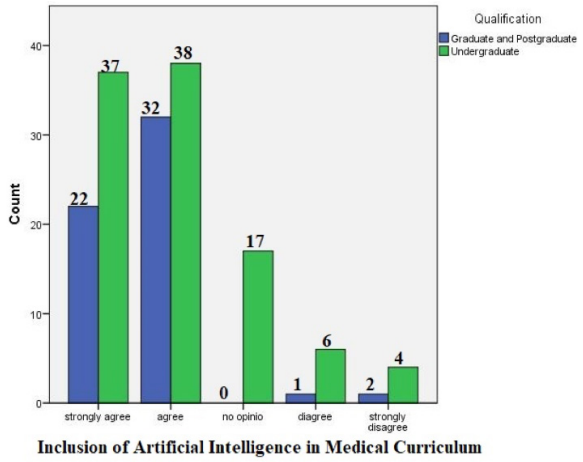



Figure 1. Perceptions of graduates and undergraduates about the inclusion of artificial intelligence in the medical curriculum.

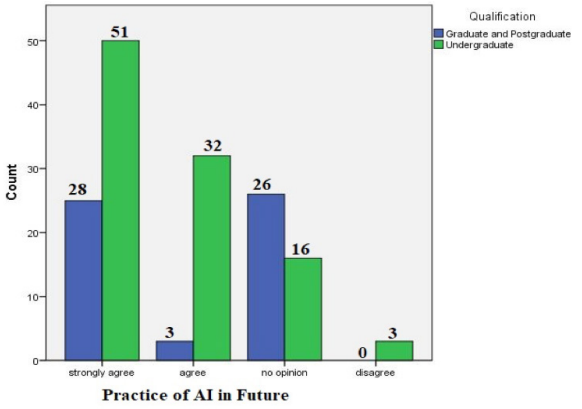



Figure 2. Practice of artificial intelligence in the medical field by graduates and undergraduates in the future.

*Practice of artificial intelligence*

The majority (75%) of the participants who have applied AI in medical practice had been taught about it; only 12.6% of those who applied AI had never been taught about it, and the difference was statistically significant (Table 2). Graduates and postgraduates (43.9%) who had applied AI in medical practice significantly outnumbered undergraduates (14.7%) who had applied AI (Table 4). With respect to the opportunity to practice AI in the medical field in the future, 51 and 32 undergraduates strongly agreed and agreed, respectively, whereas 28 graduates and postgraduates strongly agreed and 3 agreed; 26 had no opinion (Figure 2).

## Discussion

Our study provides basic insight into the attitude of medical professionals—undergraduates, postgraduates, and healthcare specialties—towards artificial intelligence in medical practice. Out of 159 participants in our study majority of those taught about AI had significantly more basic knowledge about it (96.9%) than those not taught about it (81.1%). Knowledge about deep learning was significantly higher among men (43.9%) than women (16.1%). The majority of the participants strongly agreed (84.4%) that AI is essential in medical practice. As we all are becoming aware through social media platforms, the digitalization of healthcare delivery, which is a revolutionary process, allows for efficient and accurate completion of tasks using human intelligence-centered algorithms in healthcare practices [25, 26]. The healthcare system and the healthcare-associated workforce faced unprecedented challenges during the COVID-19 pandemic due to constrained resources and reallocation in developing countries, and the need for AI for assisting physicians with re-

mote patient management was identified [23].

The data scarcity on the introduction of AI in the field of medicine has been a challenge in the Kingdom of Saudi Arabia, whereas the implementation requires some knowledge, a positive attitude, and willingness to practice it. In our study, the results showed that more than half of medical professionals had some basic knowledge about artificial intelligence. Our finding is consistent with a study carried out in medical institutes of Pakistan, where over two-thirds (71.3%) of the doctors and students mentioned that they had some knowledge of AI [27].

Machine learning and deep learning are subtypes of AI, with the former requiring predesigned features and input based on algorithms and the latter more advanced and not needing any precalculated characteristics [26, 28]. The majority of undergraduate students, postgraduates, and specialists in our study who were taught about AI knew about ML and DL as well. However, another related study showed less knowledge among medical students and doctors in Pakistan about ML and DL, which is contradictory to our study findings [27]. The high level of knowledge found in our study could be due to foreseeing the benefits of digitalization; therefore, the health system in the KSA aims to update people about technological innovations as part of their education [29]. With respect to gender, males had more knowledge about deep learning in our study as compared to females, which is consistent with evidence reported in a study conducted among Pakistani doctors and medical students where male participants were found to have greater knowledge [27].

A powerful indicator to assess workforce readiness to use AI and willingness to conduct future research on utilizing user-friendly technology is termed “perceptions,” which we assessed as groundwork before introducing formal AI training and process in order to maximize engagement with and support of AI use [30]. In our study, around half of participants agreed that AI is essential in medical practice and acknowledged that AI is a crucial medical advancement. Previous studies also reported a consistent finding that AI is acknowledged for its essential role in the medical field by a majority of three-quarters of the participants in our study [27, 31]. A study conducted in London among healthcare professionals of a National Health Service (NHS) trust assured their strong support of AI in healthcare, which corresponds to our study findings [32]. Lately, growing acknowledgment of AI technology has been observed due to the potential impact of AI in the field of medicine and surgery, expert voices speaking out on behalf of its usage

in the healthcare industry, advocacy by the think tanks for its implementation, and research and policy development favoring AI [33, 34]. Researchers, scientists, educationists, and medical specialists all should pay more heed and make an effort to increase understanding and positive perceptions among healthcare professionals.

To successfully implement artificial intelligence in healthcare settings, positive perceptions are needed among the healthcare workforce, which could be a key factor in AI implementation and might increase the likelihood of applications of AI in healthcare settings in the future [35].

Established evidence suggests that AI implementation in healthcare could reduce diagnostic errors, and medical professionals are optimistic regarding its implementation, additionally claiming that it can serve as a practitioner's diagnostic aid rather than replacing physicians and surgeons [36]. However, in a nationwide survey conducted among surgeons of the Dutch Association, few expected a reduction in complications with the help of AI while, the majority were apprehensive of issues or complications that might arise in surgical procedures after using an AI as a surgical guidance tool [6]. Approximately three-quarters of our study participants had a positive attitude and an intention to incorporate AI in the medical field in the future.

In addition, more than half of our study population agreed with including AI in the curriculum of medical schools, which is similar to findings reported by researchers in the USA and Pakistan [27, 37]. However, our study results regarding the application of AI showed that it was less often used by those of certain genders and qualifications; however, it was more often applied by those who had been taught about it before. Recent studies have identified that the major reasons behind a failure to implement AI are a lack of accurate knowledge, a deficiency of skills to apply it, disinterest, fear of being replaced by it, a lack of training, no inclusion of the subject in the curriculum, and deficiencies in technology due to a lack of financial resources [6, 27]. A recent faculty and student survey was conducted in order to determine attitudes towards artificial intelligence, specifically about integrating data science application-based clinical practice into the medical education curriculum, which showed that students were looking forward to practicing AI in patient care, while faculty and staff were more inclined towards teaching and training related to AI [38]. Recently, it has been widely observed that artificial intelligence is being added to the curriculum of graduate research programs and medical schools, with the aim of students gaining in-depth knowledge, adopting a positive

attitude, familiarizing themselves with a revolutionary technology, and acquiring skills relating to the most practical aspects possible in order to apply them in practice in the field of medical care, which is the ultimate goal [39].

The need to reform medical education has been identified lately due to the evolution of AI and its growing involvement in medical care, as there could be an increase in the use of data for clinical judgment, which would increase the need for a skilled human workforce to ensure successful medicine–machine interaction [40]. However, researchers have found some challenges and issues with integrating artificial intelligence in medical education, including the need for the assessment of AI's effectiveness in the medical education curriculum and technical issues faced during the development of AI applications [34].

The literature also reports that fear has been observed among the healthcare workforce about job replacement due to AI, although studies have supported the use of AI and noted that it has the potential to ease the human resources crisis by aiding diagnostic facilitations, decision making in clinical outcomes, and administration and analysis of big data—but with careful handling of technological, ethical, and legal aspects to keep patients' information private [41].

Our study has some strengths in terms of highlighting the important facts that the majority of medical students and doctors have basic knowledge about AI, and its subtypes, i.e., ML and DL, but lack of knowledge on its applications in the healthcare setting. However, the attitudes of medical professionals and students towards the use of AI were generally positive and they were strongly willing to consider its inclusion in the medical curriculum and in practice in the future. A few limitations to our study can be summarized as well. The research was conducted at one medical institute (due to the fact that there is only one medical college in AlAhsa) and thus the findings cannot be generalized to other healthcare settings. Our study sample size was also small, although it was scientifically calculated to capture a sufficient study population. The majority of the participants were young undergraduate students and so the results could be biased towards a younger generation whose inclination towards technology is greater compared to an older age group.

## Conclusions

The majority of doctors and medical students have basic knowledge of AI but the implementation of AI in a medical setting is lacking. The introduction of artificial intelligence to the medical curriculum, along

with its subtypes, i.e., machine learning and deep learning, presages the successful implementation of these revolutionary technologies. Willingness to use artificial intelligence is present among healthcare professionals and students in medical management. There is a need for rigorous research, education, and focused training of present and future doctors to make them learn the significance of, and acquire the skills necessary to implement, artificial intelligence as part of modern technology.

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