Investigating Students’ Perceptions Towards Artificial Intelligence in Medical Education

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Abstract

Objective: Implementing a reform in medical education requires students’ awareness regarding the importance of artificial intelligence (AI) in modern medicine practice. This study aimed to investigate students’ perceptions towards AI in medical education.

Subject and Methods: A cross-sectional survey was conducted from June 2021 until November 2021, using an online questionnaire to collect data from medical students in the faculty of medicine at Kuwait University.

Results: The response rate was 51.0%, with a sample size of 352. The majority agreed that AI will play an important role in healthcare (349 (99.1%)). More than half of the students understood the basic principles of AI; and 329 (93.4%) students showed comfortability with AI terminology. Many students (329 (83.5%)) believed that learning about AI benefits their careers, and 289 (82.1%) believed that medical students should receive AI teaching.

Conclusion: The study reveals students had positive perceptions towards AI. The role of AI in the future of medicine is significant. AI-dominated medical practice is required, and AI will not displace doctors but will create new roles.

Introduction

In the medical context, the application of artificial intelligence (AI) is aimed at “supporting decision-based medical tasks through knowledge- and/or data-intensive computer-based solutions that ultimately support and improve the performance of a human care provider” (Artificial intelligence in medicine Journal). AI systems can perform numerous functions to provide support to clinicians in drug development, disease diagnostics, health monitoring, medical data management, treatment personalisation, and the analysis of health plans, surgical treatments, and medical treatments (Amisha et al., 2019). Consequently, AI systems have gained popularity in the field of medicine after successful implementations of AI-based machine learning, which is one of the most forms of AI to use algorithms to program and teach machines to analyse certain types of data, such as in diagnosis and treatment recommendations (Davenport and Kalakota, 2019).

Introducing AI applications in healthcare can reform the way that physicians practise medicine through increasing diagnostic accuracy and the appropriateness of treatments. Such reform requires physicians to have good understanding and perceptions of AI and a willingness to use AI applications efficiently (Amisha et al., 2019; Dos Santos et al., 2019; Sit et al., 2020). Many studies have reported on the use of AI applications in many medical specialities, most dominantly in diagnostic radiology (Noguerol et al., 2019), pathology (Moxley-Wyles et al., 2020), cardiovascular medicine (Benjamins et al., 2019), ophthalmology (Ting et al., 2019), dentistry (Amisha et al., 2019), and dermatology (Polesie et al., 2020).
Therefore, attention has to be paid to the medical education of the next generation of doctors, as they need to be prepared for real clinical practice, which can be via AI applications that require new competencies for utilising a massive medical dataset and analysing/forecasting outcomes. Thus, future physicians should become educated users able to objectively analyse the use of AI systems, better understand AI concepts, and assess discrepancies between algorithms generated for medical tasks (Karaca et al., 2021).

A Korean study explored doctors’ attitudes towards the adoption of AI systems in healthcare and concluded that most of them were not familiar with AI but agreed on the usefulness of AI in medical practice; the doctors also stated that AI could not replace their roles (Oh et al., 2019). On the other hand, misunderstandings about AI can make users fear adopting it in the future. This was reported in a Swiss study that found a lack of AI knowledge among a small batch of medical students (n = 55), which was considered a potential threat to the application of AI in diagnostic radiology (van Hoek et al., 2019; Shortliffe, 2003, P. 611–613). It is imperative to avoid confusion concerning the concept of AI in medicine and improve awareness early on.

Therefore, medical education should not only teach the foundation of biomedical and clinical sciences, but also cover a broad range of skills that are required for future physicians to be effective in their use of AI systems in clinical practice (Shortliffe, 2003, P. 611–613; Wartman and Combs, 2018; Paranjape et al., 2019).

**Conceptual background**

In 2007, the Association of American Medical Colleges (AAMC) recommended that medical schools incorporate technology into medical education, such as the use of simulation technologies. Thus, with the event of emerging AI-based machine learning, medical education needs to move from the information age to the AI age to support the clinical practice with proper decisions (Wartman and Combs, 2018).

Incorporating AI concepts and applications into medical curricula can be advantageous for students, wherein AI systems can play an important role in the education process (Shortliffe, 2003, P. 611–613; The Association of American Medical Colleges, 2007). They can provide the following: (1) a multi-sensory and stimulating environment, which can increase students’ attention and participation in the learning process, so knowledge acquisition will be improved and competencies will be gained, (2) feedback about learners’ performance, which can help in monitoring their level of improvement, (3) opportunities to engage in problem-based learning at any time and with a variety of cases, without danger to real patients, and (4) an opportunity to observe medical cases on a model in a variety of grades, introducing different interventions in a safe environment.

Implementing a reform in medical education requires students’ readiness and awareness regarding the importance of adopting AI concept in medicine in order to equip them with the knowledge and skills required for future medical practice.
A few studies in the extant literature have examined this topic and have explored students’ awareness and attitudes towards AI in radiology and medicine (Dos Santos et al., 2019; Sit et al., 2020; Chen et al., 2010). There has been no research of this kind in Kuwait or other Arabian Gulf countries; therefore, this study aimed to investigate students’ perceptions towards adopting AI systems in medical education, which in turns provide an opportunity to fill the research gap in the literature.

The outcomes of this study would identify the perception of the students regarding AI systems and their readiness to adopt them in their learning within Kuwait University’s Faculty of Medicine (KUFoM).

Methods

Study design, population, and research setting

A cross-sectional survey study was conducted, using an online questionnaire to collect data from KUFoM students from June 2021 until November 2021. The undergraduate medical doctorate programme involves three phases, namely: A foundation year (phase I), a preclinical phase (phase II) that covers three years in duration, in addition to the clinical phase (phase III), which is three years too. This study was only conducted on students of phase II and phase III and excluded the foundation year, wherein basic sciences are taught, such as chemistry, mathematics, biology, and physics.

The survey questionnaire

The items of the questionnaire were taken from previous studies (Sit et al., 2020; Holder et al., 2018). The questionnaire was revised by an academic team that consists of three assistant professors from faculty of medicine and a senior lecturer with health informatics background from faculty of allied health sciences at Kuwait University in order to ensure the content validity of the questionnaire items are meeting the objectives of this study. In this process, the items were reviewed against the clarity of wording to avoid ambiguous statements, and to ensure the wording is free from any kind of bias. Also, it was assured that the scale used is appropriate and compatible with the item’s wording. Thus, a pilot study was conducted with 20 students to examine the suitability and readability of the questionnaire, and no feedback for any required modification was reported. The reliability of the questionnaire items was measured using test-retest technique, where the questionnaire should be given twice to the same students at different times. The 20 students were tested on Saturday and then retested the following Saturday. Accordingly, the total scores of the two tests were correlated, using Intraclass Correlation, where the value $\rho = 0.984$, which indicated a very high correlation (excellent reliability).

The questionnaire consisted of three sections, namely (1) demographic data, (2) perceptions towards AI, and (3) the impact of AI on medical education.

The questionnaire was developed in an electronic format using Google Docs. The data collection was achieved by distributing a link to the questionnaire via the university email system to all students in phases II and III.
Ethical consideration

Ethical approval was obtained from the Health Sciences Centre Ethical Committee at Kuwait University (Reference number: VDR/EC/3730). The study was conducted in accordance with the principles and guidelines of the Declaration of Helsinki for medical research involving human subjects. An informed consent form was obtained from each participant who agreed to participate in completing the questionnaire.

Construct validity of the questionnaire’s items

Construct validity of the two questionnaires’ scales was tested using factor analysis.

Students’ perception scale (10 items)

Factor analysis test was performed on 10 items, one common factor was extracted for 9 items and one item (no. 2) looked weak (less than 0.30) (Table 1) (Noting Table 1 location in the margin: After this paragraph). The reliability test of the 10 items was performed, which indicated an acceptable level, where Cronbach’s Alpha = 0.755

<table>
<thead>
<tr>
<th>Items</th>
<th>Loading</th>
<th>Common factor = 32.76% of variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- AI will play an important role in health care</td>
<td>.482</td>
<td></td>
</tr>
<tr>
<td>2- AI will replace some specialties in healthcare during my lifetime</td>
<td>.255</td>
<td></td>
</tr>
<tr>
<td>3- I understand basic AI principles</td>
<td>.699</td>
<td></td>
</tr>
<tr>
<td>4- I am comfort with AI terminologies</td>
<td>.670</td>
<td></td>
</tr>
<tr>
<td>5- I understand AI limitations</td>
<td>.437</td>
<td></td>
</tr>
<tr>
<td>6- AI teaching will benefit my career</td>
<td>.525</td>
<td></td>
</tr>
<tr>
<td>7- All medical students should receive AI teaching</td>
<td>.472</td>
<td></td>
</tr>
<tr>
<td>8- I will be confident using AI tools at the end of my medical degree</td>
<td>.691</td>
<td></td>
</tr>
<tr>
<td>9- I will have better understanding of the methods used to assess healthcare AI performance at the end of my medical degree</td>
<td>.701</td>
<td></td>
</tr>
<tr>
<td>10- I will possess the knowledge needed to work with AI in routine clinical practice at the end of my medical degree</td>
<td>.619</td>
<td></td>
</tr>
</tbody>
</table>

Eigen Value = 3.276
Impact of AI on medical education (5 items)

Factor analysis test was performed on 5 items; one common factor was extracted for 4 items and one item (no. 4) looked weak (less than 0.30) (Table 2) (Noting Table 2 location in the margin: After this paragraph). The reliability test of the 5 items was performed, which indicated an acceptable level, where Cronbach’s Alpha = 0.635.

Table 2
Factor analysis of the “Impact of artificial intelligence on medical education” scale

<table>
<thead>
<tr>
<th>Item no.</th>
<th>Common factor = 46.64% of variance</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- AI systems would have a positive impact on medical education</td>
<td></td>
<td>.811</td>
</tr>
<tr>
<td>2- Incorporating AI systems in medical education would ease your learning process</td>
<td></td>
<td>.810</td>
</tr>
<tr>
<td>3- Use AI systems in medical education would prepare you for real clinical practice</td>
<td></td>
<td>.750</td>
</tr>
<tr>
<td>4- Use AI systems in medical practice would replace your future role as a physician</td>
<td></td>
<td>.176</td>
</tr>
<tr>
<td>5- The willingness of using AI in medical education system</td>
<td></td>
<td>.651</td>
</tr>
</tbody>
</table>

Eigen Value = 2.332

Statistical analysis

Data management, analysis, and presentation were completed using the Statistical Package for the Social Sciences (SPSS) software, version 26.0. Descriptive statistical analysis was used to produce the frequencies and percentages for all items in the questionnaire. Chi-square tests were applied to find any correlations or significant differences between the categorical variables, where p was considered significant at p < 0.05.

Results

Survey respondent summary

Out of the 691 students contacted, 352 completed the questionnaire, giving a 51.0% response rate. In total, 48.5% of those in phase II of the undergraduate medical doctorate programme responded, while 53.9% of those in phase III responded.
Descriptive statistics

Table 3 (Noting Table 3 location in the margin: After this paragraph) shows the demographic and general characteristics of the study sample, comprising 352 students aged 18–26 years, with a mean age of 22.1 years (± 1.8 Standard Deviation). The majority of the students (88.9%) were female. The sample included very similar numbers of phase II and phase III students (178 (50.6%) and 174 (49.9%), respectively). Regarding the computer literacy level, the majority of the students were competent (75.3%). Around 58.5% of the students always used computer technology for learning at medical school, whereas 3.1% never used it.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (in years)</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>39 (11.1)</td>
</tr>
<tr>
<td>Female</td>
<td>313 (88.9)</td>
</tr>
<tr>
<td>Current academic study year</td>
<td></td>
</tr>
<tr>
<td>Second to fourth (Phase II)</td>
<td>178 (50.6)</td>
</tr>
<tr>
<td>Fifth to seventh (Phase III)</td>
<td>174 (49.4)</td>
</tr>
<tr>
<td>Computer literacy level</td>
<td></td>
</tr>
<tr>
<td>Literate</td>
<td>66 (18.8)</td>
</tr>
<tr>
<td>Competent</td>
<td>265 (75.3)</td>
</tr>
<tr>
<td>Proficient</td>
<td>21 (5.9)</td>
</tr>
<tr>
<td>Usage of computer technology for learning</td>
<td></td>
</tr>
<tr>
<td>Always</td>
<td>206 (58.5)</td>
</tr>
<tr>
<td>Sometimes</td>
<td>135 (38.4)</td>
</tr>
<tr>
<td>Never</td>
<td>11 (3.1)</td>
</tr>
</tbody>
</table>

Students’ perception towards AI
Table 4 (Noting Table 4 location in the margin: After the paragraph starting with “Less than half of the students (40.9%) disagreed that they will be confident using AI tools at the end of their medical degrees”) shows the students’ awareness of and perceptions towards AI. The majority either strongly agreed or just agreed that AI will play an important role in healthcare (56.5% and 42.6%, respectively). More than half of the participants (68.2%) agreed that AI will replace some healthcare specialties during their lifetimes, while 31.8% disagreed. When asked about their understanding of basic computational principles of AI, 60.5% reported that they understood them, whereas 39.5% disagreed. Most of the students (93.4%) showed comfortability with terminologies related to AI.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree n (%)</th>
<th>Agree n (%)</th>
<th>Disagree n (%)</th>
<th>Strongly disagree n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI will play important role in healthcare</td>
<td>199 (56.5)</td>
<td>150 (42.6)</td>
<td>2 (0.6)</td>
<td>1 (0.3)</td>
</tr>
<tr>
<td>AI will replace some specialties in healthcare during my lifetime</td>
<td>63 (17.9)</td>
<td>177 (50.3)</td>
<td>100 (28.4)</td>
<td>12 (3.4)</td>
</tr>
<tr>
<td>I understand basic AI principles</td>
<td>24 (6.8)</td>
<td>189 (53.7)</td>
<td>124 (35.2)</td>
<td>15 (4.3)</td>
</tr>
<tr>
<td>I am comfortable with AI terminologies</td>
<td>105 (29.8)</td>
<td>224 (63.6)</td>
<td>22 (6.3)</td>
<td>1 (0.3)</td>
</tr>
<tr>
<td>I understand AI limitations</td>
<td>38 (10.8)</td>
<td>200 (56.8)</td>
<td>105 (29.8)</td>
<td>9 (2.6)</td>
</tr>
<tr>
<td>Al teaching will benefit my career</td>
<td>105 (29.8)</td>
<td>224 (63.6)</td>
<td>22 (6.3)</td>
<td>1 (0.3)</td>
</tr>
<tr>
<td>All medical students should receive AI teaching</td>
<td>111 (31.5)</td>
<td>178 (50.6)</td>
<td>63 (17.9)</td>
<td>0</td>
</tr>
<tr>
<td>I will be confident using AI tools at the end of my medical degree</td>
<td>52 (14.8)</td>
<td>156 (44.3)</td>
<td>129 (36.6)</td>
<td>15 (4.3)</td>
</tr>
<tr>
<td>I will have better understanding of the methods used to assess healthcare AI performance at the end of my medical degree</td>
<td>34 (9.7)</td>
<td>159 (45.2)</td>
<td>139 (39.5)</td>
<td>20 (5.7)</td>
</tr>
<tr>
<td>I will possess the knowledge needed to work with AI in routine clinical practice at the end of my medical degree</td>
<td>28 (8)</td>
<td>179 (50.9)</td>
<td>129 (36.6)</td>
<td>16 (4.5)</td>
</tr>
</tbody>
</table>

AI: artificial intelligence
The results show that 67.4% of the students understood AI limitations, while 32.6% did not. The great majority of the students (93.4%) agreed that learning about AI would benefit their careers, and 82.1% believed that all medical students should receive AI teaching.

Less than half of the students (40.9%) disagreed that they will be confident using AI tools at the end of their medical degrees; similarly, 40.2% of the students disagreed that they will have a better understanding of the methods used to assess the performance of healthcare AI at the end of their medical degrees. In addition, 41.1% of the students did not think that at the end of medical school they will possess the knowledge needed to work with AI in routine clinical practice.

The impact of AI on medical education as seen by the study participants and their willingness to use it

Table 5 (Noting Table 5 location in the margin: After this paragraph) highlights the impact of AI on medical education as seen by the students and their willingness to use it. The majority agreed that AI systems could have a positive impact on medical education and that incorporating AI into medical education would ease the learning process and prepare students for real clinical practice (66.2%, 57.7%, and 51.7%, respectively). Most of the students (78.7%) did not think that AI will replace the roles of physicians in the future, and the willingness among the students to use AI in their medical education was high (91.5%).

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree n (%)</th>
<th>Agree n (%)</th>
<th>Disagree n (%)</th>
<th>Strongly disagree n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI systems will have a positive impact on medical education</td>
<td>107 (30.4)</td>
<td>233 (66.2)</td>
<td>12 (3.4)</td>
<td>0</td>
</tr>
<tr>
<td>Incorporating AI in medical education would ease the learning process</td>
<td>122 (34.7)</td>
<td>203 (57.7)</td>
<td>23 (6.5)</td>
<td>4 (1.1)</td>
</tr>
<tr>
<td>Using AI in medical education will prepare me for real clinical practice</td>
<td>94 (26.7)</td>
<td>182 (51.7)</td>
<td>70 (19.9)</td>
<td>6 (1.7)</td>
</tr>
<tr>
<td>AI will replace my future role as a physician</td>
<td>17 (4.8)</td>
<td>58 (16.5)</td>
<td>177 (50.3)</td>
<td>100 (28.4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Statement</th>
<th>Very willing n (%)</th>
<th>Willing n (%)</th>
<th>Not willing n (%)</th>
<th>Not at all willing n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willingness to use AI in medical education</td>
<td>120 (34.1)</td>
<td>202 (57.4)</td>
<td>27 (7.7)</td>
<td>3 (0.9)</td>
</tr>
</tbody>
</table>

AI: artificial intelligence
The status of study participants in terms of previous teaching or training in AI

Figure 1 (Noting Fig. 1 location in the margin: After this paragraph) illustrates the status of the students in terms of whether they had received any teaching or training in AI. The majority (84%) of the students had not received any teaching or training in AI, while 16% had. Of those who had received it, the teaching or training was a compulsory part of their medical degrees for 67% of the students, and 46% of them found it only somewhat useful. Moreover, 12% had found this teaching or training extremely useful, whereas 11% had not found it useful at all.

The association between academic year and the perception towards AI

Figure 2 (Noting Fig. 2 location in the margin: After this paragraph) reveals that students in phase III were more likely to agree with the statement “I understand AI limitations” than their phase II counterparts (p = 0.004). In addition, as Fig. 3 shows (Noting Fig. 3 location in the margin: After this paragraph), phase III students were less likely to agree with the statement “I will have a better understanding of the methods used to assess healthcare AI performance at the end of my medical degree” compared to phase II students (p = 0.003). Figure 4 (Noting Fig. 4 location in the margin: After this paragraph) shows the agreement level with the expectation of possessing the knowledge needed to work with AI in routine clinical practice at the end of the medical degree, which was significantly associated with the academic phase (p = 0.032).

The association between academic year and previous AI teaching or training, the impact of AI on medical education and willingness to use it

In regard to the association between academic phase and previous AI teaching or training, the Pearson's Chi-square test found no significant association (p = 0.959). On the other hand, a significant association was found between academic phase and believing that “AI will replace the roles of physicians in the future”, as phase III students were more likely to strongly disagree with this statement compared to phase II students (p = 0.027).

The results show that there was no significant association between academic phase and the willingness to use AI in medical education, where p = 0.334.

Discussion

The mean age and female-to-male distribution of the sample reflect the characteristics of KUFoM's student population of young ages and female predominance. Most of the students had competent computer skills and always used technology in their learning, which is to be expected nowadays. The findings show that most of the students showed positive perceptions towards AI, and the majority were willing to adopt it in medical education.
Perception towards AI among medical students

AI has gained significant attention in healthcare lately and is proving to be an important aspect of the future of healthcare, including applications in pharmaceuticals, health informatics, image and scan analysis, medical devices, and so on (Hamet and Tremblay, 2017; Wallis, 2019). The vast majority of the students believed that AI will play an important role in healthcare. Similar findings were reported for medical students in a United Kingdom (UK) study (Sit et al., 2020) and in a study in the United States of America (USA), in which more than 75% of the medical students believed that AI would have a moderate-to-major effect on medicine during their careers (Park et al., 2021). In the current study, it was not surprising to find that almost all of the students (93.4%) thought that receiving AI teaching would benefit their careers. This finding was consistent with previous studies (Dos Santos et al., 2019; Sit et al., 2020). However, there have been examples of AI technology failures, such as IBM’s Watson for Oncology, which was adopted by a few hospitals but was later recalled for producing suboptimal results – after millions of dollars had been spent on the project (Park et al., 2019). Moreover, experts have reported that AI and medical professionals complement each other and that although it will change medical practice, AI is unlikely to replace humans anytime soon – if ever (Hamet and Tremblay, 2017; Sanal et al., 2019; Krittanawong, 2018). It is very important to differentiate between ‘displacement’ and ‘replacement’, in which AI that acts as a replacement for physicians can be used to support healthcare providers in cases of shortages of experts. In the current study, around two-thirds of the students believed that AI will replace some specialties in healthcare during their lifetimes, and a similar finding was reported among almost half of the UK medical students in one study (Sit et al., 2020). By contrast, the vast majority of the students (96.6%) in a study of German universities disagreed that human physicians could be replaced by AI in the foreseeable future (Dos Santos et al., 2019).

The students generally reported that they had an understanding of AI terms, limitations, and principles. Similar findings were found in a UK study, wherein the medical students said they understood the basic computational principles associated with AI and AI’s limitations but were not comfortable with AI terminology (Sit et al., 2020). In a Canadian study, most of the medical students (78.9%) self-reported that they had a good understanding of AI; however, the same study used an assessment with true/false questions that included facts and fallacies about AI to objectively test the students’ understanding of AI and concluded that a noticeably lower percentage actually understood it (Chen et al., 2010). Slightly more than half of the students in the present study believed that at the end of their medical degrees, they will be able to use AI tools, apply AI in routine clinical practice, and assess the performance of healthcare AI. A possible explanation for this is that medical students at Kuwait University possibly possess an over-simplified understanding of AI, the solidness of which was not objectively assessed in this study, which was one of its limitations. This is reinforced by the finding that only a small percentage of the sample had acquired their AI knowledge through training courses. In a cohort of UK medical students, the responses were drastically different, with the majority not feeling that they will be ready to work with AI, be confident in using AI tools if required, or understand the methods used to assess AI performance by the end of their degrees (Sit et al., 2020).
Teaching and training in AI among medical students

The findings of this study reveal that a small percentage (a quarter) of the students had received some form of AI teaching or training, and no association was found between current academic phase (preclinical vs. clinical phase) and previous AI teaching or training. This indicates the lack of a formal source of AI tuition in the academic institution, highlighting the need to incorporate AI concepts into the medical curriculum. It seems that the vast majority of the students could have gained their AI knowledge from a myriad of sources that are not necessarily accurate or consistent. Previous studies from the USA, Germany, Canada, and the UK reported that the percentages of students who had been exposed to AI in an academic setting were 18%, 55.9%, 46.5%, and 9.2%, respectively (Park et al., 2021; Dos Santos et al., 2019; Chen et al., 2010; Sit et al., 2020). However, the nature of the exposure or teaching in each case was different. These studies found that the students who had received teaching or training in AI were more confident in their responses regarding understanding AI principles and showed greater readiness to use AI in clinical practice (Park et al., 2021; Dos Santos et al., 2019; Chen et al., 2010; Sit et al., 2020).

The current study found that the majority of the participated medical students were willing to receive AI teaching as part of the medical programme, which was similarly reported by students in the UK and Germany (Chen et al., 2010; Sit et al., 2020). Therefore, curriculum makers at medical schools need to act proactively and prepare students for future medical practice (Paranjape et al., 2019; Masters, 2019). For instance, the University of Ulsan and Yonsei University in Korea have started offering AI-focused elective courses to their students (Park et al., 2019). Moreover, some universities were initiatives in applying the concepts of AI in medical education, in which medical students are working in groups to create ideas-based technology to enhance health care, such as Duke Institute for Health Innovation and University of Virginia (Paranjape et al., 2019).

The perceived impact of AI on medical education and willingness to use it

Certainly, technology can transform people’s lives, and people interact with technology within an environment. A belief in the potential for AI applications to reform medical education was obvious among the students. The various methods through which AI could transform the learning environment include intelligent tutoring systems that help to spot gaps in students’ knowledge and address them, virtual facilitators, data mining, intelligent feedback, and so forth (Masters, 2019). The vast majority of the students revealed positive attitudes towards the impact of AI in medical education and believed that it will ease the learning process. Besides the fact that the current generation of students love to use technology, it seems that the recent COVID-19 pandemic, with its substantial negative impact on medical education all over the world in general and in Kuwait specifically, could have influenced the students’ responses, tipping the scale even more towards favouring the use of AI in medical education. Moreover, most of the students believed that the use of AI in their medical education could prepare them for real clinical practice. This indicates that the students perceived the importance of the impact of AI systems as
a supportive tool in the learning process. This was reinforced by the optimistic views of the students, as the vast majority of them were willing to use AI in their medical education.

**Attitudinal differences among the students by academic phase**

The findings reveal that the phase III students were more agreeing that they understood AI's limitations, than their phase II counterparts, but they showed less confidence in their responses in their ability to assess healthcare AI performance in the future or in possessing the knowledge required to work with AI in routine clinical practice at the end of their medical degrees. This could be owing to the fact that, compared to their younger phase II colleagues, phase III students are currently in the realm of ‘clinical’ training. Thus, they could have greater awareness of the challenges of using AI in clinical practice. On the other hand, phase II students have not yet experienced the clinical nature of medicine and will have their own theoretical (mostly) views on it. In addition, the phase III students were more likely to strongly disagree and less likely to strongly agree with the statement that AI will replace their roles as physicians in the future. Similarly, this was expected from this group of students, who have seen up close the irreplaceable roles that physicians play in the various aspects of medical practice.

**Limitations**

This study had limitations: (1) the survey was based on a self-reported questionnaire, so the students might have exaggerated their responses with respect to their perceptions regarding understanding of AI and their readiness to use it at the end of the medical programme; (2) due to the lack of research on similar populations in the region, most of the results were compared with studies on related topics but with populations that could have different cultures and learning environments. In addition, measuring the validity and reliability of the questionnaire with larger sample of students is suggested for future studies.

**Conclusion**

It can be concluded from the findings of this study that KUFoM students had positive perceptions towards AI systems, showing optimism towards learning more about AI in their medical education. The anticipated role of AI in the future of medical practice and medical education is significant; however, paving the road for AI-dominated medical practice is required. Lastly, AI will not displace doctors but will create new roles for them. Therefore, it is necessary for the curriculum makers at KUFoM to take applying AI systems in medical education into account, as well as any other anticipated changes and advancements in medical practice.

It is highly recommended that AI teaching/training should be embedded into KUFoM's undergraduate medical programme. This could include AI principles, data science, and ethical and legal issues. Consequently, students would acquire competencies, which include the use of intelligence tools that involve large datasets, machine learning and robotics, for the purpose of improving the patient care (Hazarika, 2020). Incorporating computer-assisted learning or AI systems into the medical curriculum
could supplement the conventional method in several ways (Shortliffe, 2003, P. 611–613), namely: (1) using AI simulation systems for preclinical, clinical, and postclinical learners to practise problem-based scenarios at different levels, as well as operate surgeries; and (2) using AI systems for performing artificial clinical examinations.

Declarations

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Competing interests

The authors have no financial or non-financial interests to declare.

Funding

No funding was received.

Ethics approval

This study was ethically approved by the Health Sciences Centre Ethical Committee at Kuwait University (Reference number: VDR/EC/3730). The study was also conducted in accordance with the principles and guidelines of the Declaration of Helsinki.

Consent

Informed consent was obtained from all participants who participated in the study.

Availability of data and materials

The datasets generated and/or analysed in the current study are available from the corresponding author on reasonable request.

References


**Figures**
Figure 1

Previous teaching or training in artificial intelligence status of the study participants. (a) The percentage of students who received teaching or training in artificial intelligence. (b) Out of those who received teaching or training in artificial intelligence, 67% received it as a compulsory part of their medical training. (c) The perceived usefulness of the teaching or training on students who received it, graded as extremely useful, very useful, somewhat useful, not so useful, and not useful at all.
Figure 2

Students’ perceptions on understanding of artificial intelligence limitations, according to the academic year. The four colours represent the levels of students’ agreement to the phrase “I understand artificial intelligence limitations”. The bar on the left portrays fifth to seventh year students, i.e., phase III students, whereas the bar on the right describes second to fourth year (phase II) students’ levels of agreement. Chi-square test for the association between academic year and agreement level generated a p-value of 0.004, with phase III students being more likely to agree to the mentioned phrase.
Figure 3

Students’ future expectation of better understanding healthcare artificial intelligence performance, according to the academic year. The four colours represent the levels of students’ agreement to the phrase “I will have a better understanding of the methods used to assess healthcare artificial intelligence performance at the end of my medical degree”. The bar on the left shows fifth to seventh year students, while the bar on the right describes second to fourth year students’ levels of agreement. Chi-square test for the association between academic year and agreement level resulted in a p-value of 0.003, with second to fourth year students being more likely to agree to the mentioned phrase.
Students’ expectation of possessing the knowledge to work with artificial intelligence in practice, according to the academic year. The four colours represent the levels of students’ agreement to the phrase “Overall, at the end of my medical degree, I feel I will possess the knowledge needed to work with artificial intelligence in routine clinical practice”. The left bar shows the agreement levels of fifth to seventh year students, while the right bar represents second to fourth year students. Chi-square test for the association between academic year and agreement level gave a p-value of 0.032, with second to fourth year students being more likely to agree to the mentioned phrase.