Case Study

Medical and Dental Professionals Readiness for Artificial Intelligence for Saudi Arabia Vision 2030

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ABSTRACT

Healthcare Artificial Intelligence (AI) readiness is defined as adequate knowledge, attitudes, and skills such that health professionals are prepared for AI use in prevention, diagnosis, treatment, and rehabilitation. The aim of this study is to assess readiness levels for AI among medical and dental professionals in Saudi Arabia. A cross-sectional study of 334 medical and dental students and practitioners in Saudi Arabia. Data were collected with a self-administered online questionnaire using the Medical Artificial Intelligence Readiness Scale (MAIRS). Data were analyzed using descriptive statistics and t-tests using SPSS software. The level of significance was set at $p \leq 0.05$. Participants' MAIRS responses ranged from a mean (m) of 2.26 and a standard deviation (SD) of 1.17 to m = 2.76 and SD = 1.7 out of 5, indicating low levels of AI readiness. Dental professionals had significantly (p < 0.05) better readiness on 21 (of 22) MAIRS items. Only one item was significantly (p<0.05) associated with gender or qualifications. Participants had low readiness levels for AI, although dental professionals had significantly better scores. It is recommended that AI material and hands-on training be provided during undergraduate and postgraduate education for Saudi Arabian medical and dental professionals.

Key words: *Artificial intelligence, Readiness, Medical, Saudi Arabia, Medical Artificial Intelligence Readiness Scale*

INTRODUCTION

Artificial Intelligence (AI) is a prominent scientific advancement changing the modern world [1, 2]. AI is defined as the engineering and science of creating intelligent machines [3] with the ability to problem-solve and learn through different modalities, including machine learning, neural networks, and natural language processing [4] AI is being used extensively in healthcare, such as, for example, in the detection of disease outbreaks [5] and water contaminations [6]. There are also many applications for AI in clinical settings, including analyzing images to detect skin cancer [7] and eye diseases [8] using echocardiograms to identify heart abnormalities [9], and performing clinical procedures in robotic surgery, as with knot tying [5]. AI also has applications in the dental field, such as for caries detection [10], oral cancer diagnosis [11], dental shad restoration selection [12], and temporomandibular diagnoses [13]. AI use helps increase healthcare efficiency and effectiveness and decreases medical malpractice [14].

The World Health Organization warned that healthcare professionals need to understand how AI operates [15], so AI will become an important domain in healthcare education [16, 17]. Future healthcare workers will use AI based on their understanding of its concepts and algorithms [18]. This is important because AI is not a magical

tool to be taken for granted, and poor implementation of AI projects could lead to inaccurate diagnoses that harm patients, which has been reported in some studies [19, 20].

Many people use AI in applications such as voice and face recognition, but few are aware of the technology, concepts, or ethical dilemmas related to AI [21, 22]. Researchers have highlighted a communication gap among healthcare workers regarding AI that might hinder the technology's efficient and proper utilization, such as with poor data storage [18]. This is why physicians must understand at least basic AI concepts to use AI potentiates appropriately.

It is expected that healthcare workers with AI knowledge will replace those without such knowledge in the future [23], in alignment with global market changes in the digital era. Several studies have investigated AI literacy and knowledge among healthcare professionals (workers and students) [24-26] However, very few have investigated AI readiness among health professionals. AI readiness in healthcare—the knowledge, attitudes, and skills that prepare health professionals to use AI applications in prevention, diagnosis, treatment, and rehabilitation [27]— is not equal to AI knowledge or literacy, but AI literacy with confidence and perception can influence AI readiness [28].

AI readiness has been investigated in various domains, including healthcare [29, 30], engineering [31], business innovation [32], governmental initiatives, and the reforming process for development in many countries, including China [33]. Most of these studies investigated readiness from a governmental perspective because there is a strong relationship between AI readiness and the economy [33]. A recent study validated the Medical Artificial Intelligence Readiness Scale (MAIRS) as a tools for measuring AI readiness among medical professionals [27]. However, the tool and readiness have not been thoroughly investigated among medical and dental professionals.

A number of reviews and commentaries have discussed AI medical uses [34-36], and a few original papers have investigated knowledge and attitudes about AI among medical doctors or students [26, 37-39]. It is worth noting that many of these studies were specifically interested in AI use for radiology [26], particularly in Saudi Arabia [37-39]. In one multi-continent study, medical doctors and students had low levels of familiarity with AI, and only 2.9–9.8% had attended courses about AI [40]. Results of Saudi Arabian studies among medical doctors and students showed low levels of knowledge about AI despite the desire to learn. There were also concerns among respondents about the possibility of AI affecting their future employment [37-39].

In the dental field, few studies have investigated AI among dentists and dental students. In Turkey, a study showed that 48.40% of dental students had basic knowledge about AI, and many of them believed that AI would change dentistry [41]. Another study in Saudi Arabia showed positive attitudes toward AI among dentists and dental students [42] However, no studies have investigated AI readiness among medical and dental professionals in Saudi Arabia using a validated method. Thus, given the major transformations in digital services and healthcare reforms in line with Saudi Arabia's Vision 2030, the aim of this project was to assess readiness for AI among medical and dental professionals in the specific Saudi Arabian setting.

MATERIALS AND METHODS

Study design
The study was approved by Umm Al-Qura University with reference number HAPO-02-K-012-2022-06-1115. This was a descriptive cross-sectional study aimed at assessing levels of readiness for AI among medical and dental students and graduates in Saudi Arabia.

Participants
A convenience sample was used, and participants were medical or dental students and graduates working at various levels (general practitioner, specialist, or consultant) in Saudi Arabia (inclusion criteria). Students in preparatory years for the health track were excluded. Also excluded were any participants who did not agree to the study's informed consent.

Setting
Data was collected between June and July of 2022. The research team used a self-reported questionnaire that was given in English because medical and dental professionals learn English in Saudi Arabia. The online questionnaire was accessed via a link sent to medical and dental professionals through social media platforms, including Instagram, Twitter, LinkedIn, and Telegram. The study link was also sent to personal contacts in the targeted fields. Participants' electronic consent was mandatory before they could complete the questionnaire via a mandatory consent form that provided information about the study's aims, requirements, inclusion criteria, and

freedom to stop participating, in addition to other information about the study's nature. All data were obtained without revealing any private information, and any information that would expose a participant's identity was eliminated.

Questionnaire (Measurement)

The questionnaire comprised 30 questions divided into two sections. Section One collected demographic data, including gender, age, city, region, specialty, workplace (university, hospital), qualifications, and nationality. Section Two assessed AI readiness using 22 questions answered on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). These questions comprise the MAIRS for medical students (MAIRS-MS), which was validated in a prior study [27] with Cronbach's alpha of 0.73.

Data analysis

The probability value of 0.05 was used for this study's analysis. SPSS version 27 (IBM, Inc., Armonk, NY, USA) and Excel (Microsoft Corporation, Redmond, WA, USA) were used to generate numbers and percentages of categorical variables and the mean with SD for continuous variables. Statistical tests included t-tests.

RESULTS AND DISCUSSION

The study's 334 participants who completed the questionnaire were from 19 cities in Saudi Arabia: Abha, Alkhobar, Alqunfudah, Arar, Buriyadh, Dammam, Haql, Jazan, Jeddah, Khobar, Madinah, Majmaa, Makkah, Najran, Qassim, Rabigh, Riyadh, Tabuk, and Taif. The participants worked at the following 22 organizations/universities: Almaarefa University, Battarji medical colleges, Imam Abdulrahman Bin Faisal University, Imam Mohammad Ibn Saud Islamic University, Jazan University, Jeddah University, King Abdualaziz University, King Abdulaziz Medical City, King Fahd Hospital of the University, King Faisal hospital, King Khalid University, King Saud bin Abdulaziz University for Health Sciences, King Saud University, Majmaah University, Ministry of Health hospitals, Najran University, Sulaiman Al-Rajhi University, Taibah University, Taif University, Umm Al-Qura University, Vision Colleges, private hospitals, and private clinics. The participants had a mean age of 22.05 and a standard deviation (SD) of 2.80. The demographic data are provided in **Table 1**.

Table 1. Participants' demographic data.

	Variable	n	%
Gender	Male	115	34.43%
	Female	219	65.57%
Specialty	Medicine	275	82.34%
	Dentistry	59	17.66%
Qualification	Student in clinical year (4th, 5th, or 6th)	270	80.84%
	Intern	25	7.49%
	Graduate (bachelor)	30	8.98%
	Specialist	6	1.80%
	Consultant	3	0.90%
Region in Saudi Arabia	Western	249	74.55%
	Central	27	8.08%
	Southern	17	5.09%
	Eastern	34	10.18%
	Northern	7	2.10%
Nationality	Saudi	328	98.20%
	Non-Saudi	6	1.80%

Participants' answers to each MAIRS item are shown in **Table 2**. When comparing MAIRS items regarding specialties using a t-test, we found that 21 items were significantly higher among dental professionals than

medical professionals, as shown in **Table 2**. Using a t-test, none of the MAIRS items were significantly different between males and females (p > 0.05). When comparing students versus interns/graduates on MAIRS items, nearly all of the MAIRS items were not significantly different except for "I can harness AI-based information combined with my professional knowledge," where interns/graduates had higher scores than students (p = 0.04).

Table 2. Participants' MAIRS answers.

MAIRS item	Total m (SD)	Medicine m (SD)	Dentistry m (SD)	p-value
I can define the basic concepts of data science.	2.71 (1.3)	2.59 (1.26)	3.29 (1.33)	<0.001
I can define the basic concepts of statistics.	2.67 (1.21)	2.54 (1.18)	3.27 (1.17)	<0.001
I can explain how AI systems are trained.	2.26 (1.17)	2.16 (1.15)	2.71 (1.15)	0.001
I can define the basic concepts and terminology of AI.	2.41 (1.23)	2.34 (1.24)	2.76 (1.16)	0.014
I can properly analyze the data obtained by AI in healthcare.	2.35 (1.19)	2.25 (1.16)	2.8 (1.24)	0.003
I can differentiate the functions and features of AI-related tools and applications.	2.42 (1.22)	2.31 (1.21)	2.9 (1.2)	0.001
I can organize workflows compatible with AI.	2.42 (1.24)	2.33 (1.22)	2.85 (1.27)	0.005
I can express the importance of data collection, analysis, evaluation, and safety for the development of AI in healthcare.	2.66 (1.25)	2.59 (1.22)	3 (1.34)	0.031
I can harness AI-based information combined with my professional knowledge.	2.45 (1.16)	2.35 (1.16)	2.9 (1.09)	0.001
I can use AI technologies effectively and efficiently for healthcare delivery.	2.58 (1.31)	2.48 (1.28)	3.05 (1.37)	0.004
I can use artificial intelligence applications in accordance with their purposes.	2.59 (1.35)	2.48 (1.32)	3.12 (1.34)	0.001
I can access, evaluate, use, create, and share new knowledge using information and communication technologies.	2.66 (1.3)	2.59 (1.3)	3.02 (1.25)	0.019
I can explain how AI applications offer a solution to specific problems in healthcare.	2.54 (1.26)	2.45 (1.26)	2.97 (1.19)	0.004
I find it valuable to use AI for education, service, and research purposes.	2.76 (1.3)	2.68 (1.32)	3.15 (1.16)	0.007
I can explain AI applications used in healthcare services to patients.	2.55 (1.25)	2.48 (1.23)	2.9 (1.27)	0.022
I can choose the proper AI application for a problem encountered in healthcare.	2.46 (1.21)	2.4 (1.2)	2.78 (1.22)	0.031
I can explain the limitations of AI technology.	2.55 (1.22)	2.47 (1.2)	2.93 (1.24)	0.01
I can explain the strengths and weaknesses of AI technology.	2.57 (1.25)	2.49 (1.2)	2.95 (1.38)	0.021
I can foresee the opportunities and threats that AI technology can create.	2.54 (1.26)	2.46 (1.26)	2.88 (1.22)	0.019
I can use health data in accordance with legal and ethical norms.	2.69 (1.33)	2.61 (1.32)	3.05 (1.34)	0.024
I can conduct under ethical principle while using AI technologies.	2.59 (1.29)	2.53 (1.29)	2.86 (1.31)	0.078
I can follow legal regulations regarding the use of AI technologies in healthcare.	2.71 (1.31)	2.61 (1.31)	3.14 (1.21)	0.004

The aim of this study was to assess the readiness for AI of medical and dental professionals in Saudi Arabia. Using the validated instrument MAIRS, the results showed that most of the participants scored 2.26–2.76 on a scale of 1 to 5, which is less than the midpoint of "3." This indicates low levels of readiness for AI. Dental professionals had significantly better readiness for most MAIRS items than did medical professionals. Gender and qualifications were not associated with readiness levels.

Our study investigated AI readiness among medical and dental professionals, filling a gap in previous studies investigating readiness in the health field; prior studies instead concentrated on knowledge and attitudes [37-42]. In agreement with our results, these previous studies indicated low levels of AI knowledge among medical doctors and students [37-40], while dental students had moderate levels [41]. Nevertheless, as already mentioned, AI knowledge and literacy do not equal or predict AI readiness [28]. This concept was found in a study in which knowledge and literacy about diabetes were not related to readiness [43]. However, even if medical and dental professionals have low or moderate AI knowledge levels, they may be willing and ready to learn about AI and its uses.

That said, our results also found that readiness levels were not satisfactory. This indicates that medical and dental professionals lack both sufficient knowledge and readiness to use AI at this time. Much effort will be required to fill this gap, but this is important because AI is reshaping the future of healthcare [44, 45], and blindly relying on such advancements alone might cause severe unintentional harm to patients, as previously reported [19, 20].

From another perspective, our findings indicated that dental professionals were significantly more ready than medical professionals, as measured by the simultaneous completion of the same questionnaire. This may be due to the dental profession being more technical and more likely to depend on machines in their work. Dentists may have adopted recent technological advances, such as 3D printing [46, 47], scanning [48], and digital radiographs [49]. It should be noted that dental participants in this study made up one-fifth of the sample. Future studies might include larger sample sizes, specifically dental professionals, to give external validity to these results.

Our results show that medical professionals are more in need of materials and hands-on sessions about AI in undergraduate and postgraduate studies to increase AI knowledge. AI should also be highlighted as an integral advancement in healthcare that should be addressed by medical professionals, boosting their readiness. This can help the next generation of medical professionals cope with the data science era and fit into an upcoming AI ecosystem [50-52]. However, this is not limited to medical professionals and should be applied to dental professionals, who still showed low levels of AI readiness in Saudi Arabia.

It is important to note that there are major transformations in Saudi Arabia according to Vision 2030. Digitalization is one of its fundamental pillars, along with a radical shift to a new model of care [53, 54]. This makes AI knowledge, literacy, and readiness vitally important [55], particularly because in the future, healthcare workers with AI familiarity will replace those who are not as well-versed [23].

There were some challenges and limitations in the current study. They include the use of a self-reported questionnaire, unequal distribution of participants from different regions of Saudi Arabia, and the use of convenience sampling to collect data. In contrast, this is the first study to measure AI readiness among medical and dental professionals in Saudi Arabia, and it can be a first benchmark for future studies in the field. A primary strength of the current study is the use of the MAIRS validated questionnaire to measure readiness for AI. Because this may be one of the earliest studies to use MAIRS, future studies in different countries are needed for more meaningful cross-cultural comparisons. In such studies, changes should be tracked longitudinally among these populations. For better usability of the scale, it is recommended that the MAIRS scoring system be modified with cutoff points for low, moderate, and high levels of readiness.

CONCLUSION

Medical and dental professionals are not yet ready for AI, based on the low levels of readiness measured in this study. While dental professionals had significantly better readiness scores than medical professionals, it is recommended that educational organizations and hospitals include AI modules and hands-on training in undergraduate and postgraduate education. This will help the next generation of medical and dental professionals cope with the data science era and be fit for the upcoming AI ecosystem in Saudi Arabia.

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