



A closer look at the current knowledge and prospects of artificial intelligence integration in dentistry practice: A cross-sectional study

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ABSTRACT

Background: Healthcare professionals have expressed worries about using AI, while others anticipate more work opportunities in the future and better patient care. Integrating AI into practice will directly impact dentistry practice. The purpose of the study is to evaluate organizational readiness, knowledge, attitude, and willingness to integrate AI into dentistry practice.

Methods: a cross-sectional exploratory study of dentists, academic faculty and students who practice and study dentistry in UAE. Participants were invited to participate in a previously validated survey used to collect participants' demographics, knowledge, perceptions, and organizational readiness.

Results: One hundred thirty-four responded to the survey with a response rate was 78% from the invited group. Results showed excitement to implement AI in practice accompanied by medium to high knowledge and a lack of education and training programs. As a result, organizations were not well prepared and had to ensure readiness for AI implementation.

Conclusion: An effort to ensure professional and student readiness will improve AI integration in practice. In addition, dental professional societies and educational institutions must collaborate to develop proper training programs for dentists to close the knowledge gap.

1. Introduction

The creation and testing of Artificial intelligence (AI) technologies in diagnostic and treatment must involve practitioners, and the

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resulting AI applications must be compatible with the clinical system needs. It is important to understand and analyse practitioners' and decision-makers' perspectives on the use of AI in primary healthcare in order to provide the groundwork for these advancements [1].

Artificial intelligence (AI) is the theory and creation of computer systems that can carry out tasks that typically require human intellect, such as speech recognition, language translation and visual perception [2]. AI technologies include machine learning (ML), which involves teaching algorithms to perform tasks using data to understand patterns and characteristics, and deep learning (DL), which uses deep neural networks with many layers of mathematical equations to complete tasks [2].

The use of AI in all aspects of healthcare delivery is rapidly expanding [3]. AI technology will significantly improve health professional practice and patient outcomes. Currently, numerous AI applications are used in dental practice, such as speech recognition, data mining, image analysis and reporting [4,5]. However, future uses of AI technology will assist dentists in delivering tailored, evidence-based treatment and integrating pertinent data [6].

A variety of AI software tools were used in clinical practice when the current health and medical students start their careers as healthcare professionals after completing their education and training [7]. Healthcare and medical professionals should be in charge when using AI technology on patients rather than taking a backseat. They should be able to allay the concerns, misunderstandings, and queries that patients and the general public may have regarding the use of AI in medicine. Making AI a tool that is useful for patient care is a responsibility shared by medical practitioners [8].

Medical companies developed cutting-edge AI products and applications for healthcare services. These applications are pricey and demand both infrastructural and human resource planning. As a result, it is crucial to make sure that they satisfy the requirements of the healthcare delivery and professions are ready to utilize them [9].

Few studies have examined the perceptions of dentistry students, in contrast to the great majority of AI research, which focuses on designing and testing AI algorithms and their associated prediction models [10–12]. Since there is little question that the use of AI in healthcare practice and education will continue to grow, it is evident that this lack of knowledge exists across the field and needs to be addressed.

Thus, it is essential to successfully integrate AI into dentistry to comprehend the attitudes and behaviours of dentists as end users of existing and future AI applications. Additionally, assessing dentists' proficiency with AI is critical to deciding whether further training will eventually be required, given that they frequently contact patients and use technology.

The current study aimed to assess the knowledge, attitude and willingness of dentists and dentistry students and their organisational readiness to integrate AI into dentistry.

2. Methods

2.1. Study design

An exploratory cross-sectional survey analyzed the knowledge, attitudes and willingness of dentistry professionals and students to accept AI in their practice. The eligibility to participate included academic staff and registered dentists and students in the final years of graduate study across hospitals, medical centres and universities during the data collection period.

2.1.1. Data instrument

The research team adapted a previously validated survey used in similar studies [8,9,13,14]. The survey was designed in two sections: the first section collected the participants' demographic information, including speciality, sex, age, qualifications, experience and the country in which they obtained the terminal academic degree. The second section collected the participants' knowledge, perceptions and organisational readiness regarding integrating AI into their practice.

Participants were invited to participate in the survey through an online survey using the Google Forms link and through direct distribution of the hard copy survey at their practice locations. The survey was distributed by a research assistant to the participant's manager and faculty at the university.

Four dentists who work in clinical and academic settings as well as two senior students piloted the survey to assess its completion time, participant comprehension of the questions, validity, and reliability of the information. Some of the reviewer's recommendations and comments were used to rephrase the questions for clarity. The primary study did not include any pilot data.

The survey link and copy had a detailed information page explaining the study objectives, information sheet and consent to participate. Participants had to approve of their participation before handing the survey back or filling it out online.

No personal information was collected, and participants had the right to withdraw before submission without repercussions. The data collection period was over two months (August to September 2022), with regular reminders.

2.2. Inclusion and exclusion criteria

Data were obtained from dentists who practiced in the hospitals and universities and were willing to participate during the study period. Invited participants who did not submit the survey in the timeframe were excluded.

2.3. Ethical approval

The study was approved by the University of Sharjah Research Ethics Committee. The objective of the study, the procedures, and

the methodology were carried out in accordance with the rules and regulations (reference number REC-20-05-06-01).

2.4. Data analysis

All the results were noted on a worksheet (Microsoft Excel version 2016, Microsoft Corporation, Redmond, Wash., USA) and analyzed using the Statistical Package for Social Sciences (SPSS) version 23. Means and standard deviations were used to describe the data based on frequency and distribution. Using the Kolmogorov–Smirnov test, the normality of the data distribution was evaluated. To determine whether there was any association between perceptions and participant demographics, a chi-squared analysis ($p = 0.005$) was conducted. ‘Neutral’ responses were disregarded, and only ‘Agree’ and ‘Disagree’ were included in the analysis.

3. Results

3.1. Demographics and participants’ backgrounds

One hundred thirty-four valid responses were received over an eight-week data collection period. The response rate was 78% for the invited group. Table 1 shows that the majority of the participants were female (64.9%, $n = 87$). Among the participants, 53.7% ($n = 72$) were undergraduate students without clinical experience, 14.2% ($n = 19$) were academic staff, and 32.8% ($n = 44$) worked as clinical dentists. The results showed that 73.1% ($n = 98$) of the participants had completed their highest academic degree in United Arab Emirates (UAE) universities, while 26.9% ($n = 36$) obtained their degree in countries other than UAE.

3.2. Perceptions assessment

Participants’ perception of AI integration in their practice was analyzed through 5 questions on a 3-point Likert scale. Scores were assigned for their responses as follows: 1 = ‘Agree’, 2 = ‘Neutral’, and 3 = ‘Disagree’, for which frequency, mean and SD ($\mu \pm SD$) were also calculated. Among the participants, 85.5% ($n = 115$) agreed that AI would play a significant role in practice (1.15 ± 0.378); 85.1% ($n = 114$) believed that AI would be used in many dentist applications (1.17 ± 0.434); and 82.1% ($n = 110$) showed readiness to learn and apply AI into their practice (1.19 ± 0.433). An equal percentage of participants, 38.1% ($n = 51$), agreed and had neutral opinions when asked if AI has any limitations in their work, and 44.8% ($n = 60$) had a neutral response when asked if AI will threaten/disrupt dentists’ professional practice (Table 2).

Therefore, 56.7% ($n = 76$) of the participants stated that they were excited about implementing AI in their practice, and 35.8% ($n = 48$) stated that they were aware of the challenges. In comparison, 7.5% ($n = 10$) stated that they were worried about the impact of their practice (Fig. 1).

3.3. Knowledge assessment

Knowledge assessment is an inseparable part of the integration of AI in healthcare practice. In addition, knowledge assessment can provide valuable information about the current education and learning status. When asked how well they understood AI, 42.5% ($n = 57$) of the participants expressed that they understood the meaning of AI. In comparison, 29.1% ($n = 39$) mentioned that they were familiar with it but would not confidently apply the knowledge at work. On the other hand, 9.7% ($n = 13$) answered that they did not know how AI works (Fig. 2).

Table 3 shows the participants’ opinions on AI education requirements. In total, 78.4% ($n = 105$) agreed that all dentistry profession curricula should include basic knowledge of AI (1.24 ± 0.4). Furthermore, the participants affirmed that AI principles should be taught in undergraduate and postgraduate programmes at 69.1% ($n = 83$) and 76.1% ($n = 102$), respectively.

It is crucial to develop knowledge and skills to improve participants’ careers and guarantee that their expertise is current. In

Table 1
Participant’s demographic information.

		N (%)
Gender	Male	47 (35.1)
	Female	87 (64.9)
Qualification	Students	68 (50.7)
	B.Sc.	47 (35.1)
	M.Sc.	10 (7.5)
	PhD	9 (6.7)
Country of Qualification	UAE	98 (73.1)
	Outside UAE	36 (26.9)
Occupation	Students	71 (53)
	Academic institute	19 (14.2)
	Hospital	44 (32.8)
Practice years	Students	72 (53.7)
	1–10 years	33 (24.6)
	over 10yrs	29 (21.6)

Table 2
Perceptions towards the implementation of AI in dentistry practice.

	Agree N (%)	Neutral N (%)	Disagree N (%)	Mean ± SD
AI will play an important role in the practice of dentists' professions.	115 (85.8)	18 (13.4)	1 (0.7)	1.15 ± 0.378
AI will take place in many applications	114 (85.1)	17 (12.7)	3 (2.2)	1.17 ± 0.434
AI will threaten/disrupt the dentist's professional practice.	42 (31.3)	60 (44.8)	32 (23.9)	1.93 ± 0.742
AI has no limitations in my work	51 (38.1)	51 (38.1)	32 (23.9)	1.86 ± 0.777
I am ready to learn and apply AI in my practice	110 (82.1)	22 (16.4)	2 (1.5)	1.19 ± 0.433

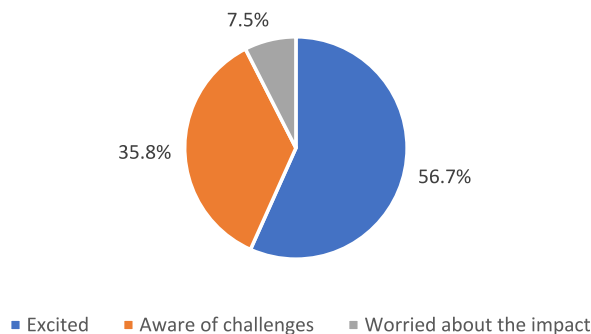


Fig. 1. How do you feel about AI?.

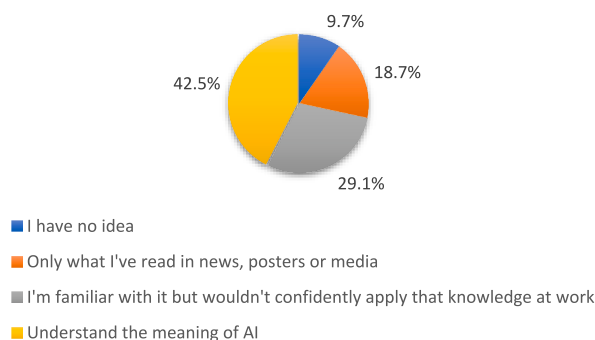


Fig. 2. How well do you understand what AI means?.

Table 3
Participant's agreement on AI education.

	Agree N (%)	Neutral N (%)	Disagree N (%)	Mean ± SD
All dentistry professions curricula should include at least some basic knowledge of AI.	105 (78.4)	26 (19.4)	3 (2.2)	1.24 ± 0.4
AI should be taught in the undergraduate programme	83 (61.9)	42 (31.3)	9 (6.7)	1.45 ± 0.6
AI should be taught in the postgraduate programme	102 (76.1)	30 (22.4)	2 (1.5)	1.25 ± 0.4

addition, a professional advantage can be gained by possessing knowledge and abilities beyond the fundamentals. Fig. 3 shows how the participants developed AI knowledge and skills relevant to their fields. Most learned about AI on their own (63%, n = 81); 17% (n = 24) stated that they had completed education or training courses and 12% (n = 17) by attending work-related activities.

3.4. Organisational readiness

An organizational readiness assessment is a standard gauge of a healthcare organisation preparation for a big change or new project. Among the participants, 54.5% (n = 73) were unsure if an office/personnel is responsible for AI implementation in their organisation. On the other hand, only 33.6% (n = 45) indicated that an AI strategy was internally developed in their organisation for future implementation, while 66.4% (n = 89) stated that they had no idea.

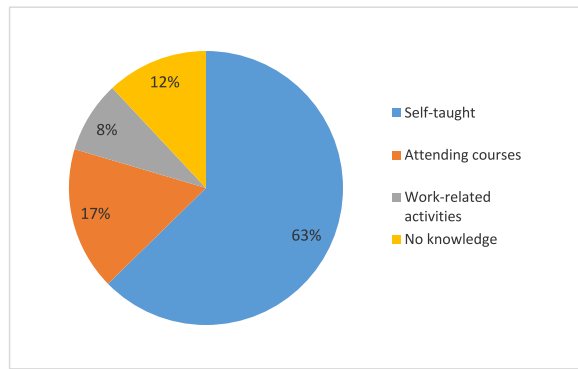


Fig. 3. How did you develop your knowledge of AI?.

3.5. Challenges

Artificial intelligence offers potential solutions to some of the challenges facing healthcare systems. However, it is widely known from implementation and innovation research that healthcare personnel frequently oppose new technology, which slows and varies the uptake of these technologies. The challenges to integrating AI in dental practices are categorised into three elements in Fig. 4. The participants were allowed to give multiple responses to each element. However, it was obvious that the availability of education, training courses, and skills development was the major challenge, followed by AI knowledge (Fig. 4).

3.6. AI application

To understand how AI can support dentists and improve patient care delivery, the participants enquired about the most AI-related applications required for practice. The highest AI application required by the participants was the detection of caries, fractures and periapical lesions (85%) compared to 36% of the respondents, indicating clinical decision-making (Fig. 5).

3.7. Comparison of demographics and responses

The correlation between the participants’ demographics and their perceptions and knowledge of AI chi-squared analysis was conducted. ‘Neutral’ responses were excluded from the analysis, and only ‘Agree’ and ‘Disagree’ were analyzed.

The study revealed an association between the educational qualifications of the participants and their opinions on the limitations AI has on their work ($p = 0.003$). Similarly, work experience ($p = 0.001$) and their workplace (0.00001) were significantly associated with their opinion on AI’s limitations on their work. Almost half of the students (58.5%) disagreed that AI has no limitation to their work, while most of the participants with BSc (79.3%), MSc (85.7%) and PhD (83.3%) agreed. The majority of the students (56.8%) who had no working experience disagreed with the same compared to the majority of participants with 1–10 years (82.4%) and over 10 years of experience (81.8%) agreed. Further, the majority of students (58.1%) disagreed, while the majority of participants employed at academic institutes (63.6%), hospitals (89.3%) and medical centres (100%) agreed that AI had no impact on their work.

A strong association was found between the participants’ country of highest qualification obtained and their response to having a basic understanding of AI ($p = 0.0001$). The vast majority of those from outside the UAE (95.8%) were inclined to agree compared to those from within the UAE (60%). In addition, the study revealed a strong association between genders and their responses to having a basic understanding of AI ($p = 0.012$) and having a working knowledge of AI ($p = 0.01$). More males (86.7%) were inclined to agree to have a basic understanding compared to women (61.2%), while the majority of men (64%) agreed to have a working knowledge. In

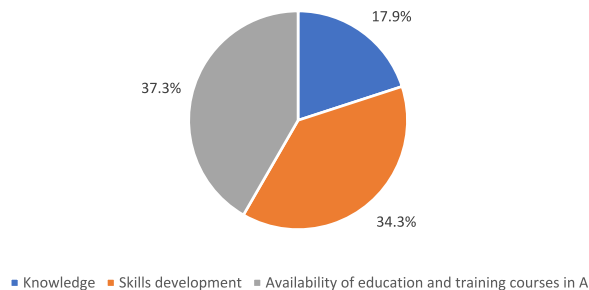


Fig. 4. Challenges in AI implementation*

*Multiple responses were allowed for this question.

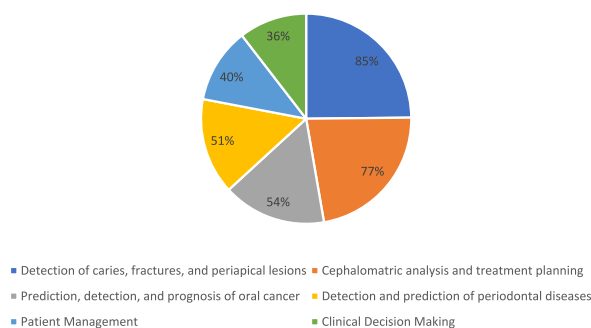


Fig. 5. AI applications required by the participants*

*Multiple responses were allowed for this question.

comparison, a majority of the women (75.9%) disagreed.

4. Discussion

AI can create revolutionary changes in the healthcare sector [12]. This study aimed to assess the perspectives of dental professionals and students regarding the implementation of AI in dentistry. The participants have diverse experiences, knowledge and exposure to AI gained so far through multiple avenues of work, professional training and social media. Almost half of the participants knew what AI is. However, the confidence/knowledge to apply AI to work was low, and many agreed that AI must be taught to undergraduates and postgraduates, which highlights the perceived importance of AI knowledge when beginning to work in dentistry.

With a greater focus on diagnostic imaging, three-dimensional scans, and cone-beam computed tomography, AI is gradually making its way into the field of radiology in dentistry. For the purpose of facilitating speedy diagnosis and treatment planning, a lot of data can be gathered and computed to build an AI.

The most recent technology innovation involves personalized orthodontic care powered by AI. Orthodontic diagnosis, treatment planning, and treatment monitoring are now all possible with AI. It is simple to 3D print the aligners with a personalized treatment plan using precise 3D scans and virtual models [15]. As the enormous amounts of data are calculated, an algorithm is developed that intelligently determines how to move a patient's tooth or teeth, how much pressure to apply, and even where the pressure points should be for that particular tooth or teeth. The AI-assisted aligners promise to shorten treatment times and simplify appointment schedules in addition to providing precise treatment execution and aiding in progress monitoring [15,16].

In total, 71.6% stated that they knew what AI was, while only 42.5% were comfortable with their knowledge of dentistry-related AI. Knowledge of AI was reported to be higher in our study than in previous studies conducted in Saudi Arabia (42.2%) [17], Central India (68%) [18] and Turkey (48.4%) [19]. However, our study's knowledge of AI related to dentistry was similar to the results from Saudi Arabia (42.2%) and Turkey (48.4%). In addition, our study stated that more men than women had a basic understanding of AI and a working knowledge underpinning the dominance of men in AI worldwide, which contrasts with previous studies.

In this study, despite 85.5% agreeing on the importance of the role in their practice, 31.3% stated that AI would threaten/disrupt their profession. This has been a very common concern, as reported in other studies in Kenya (62.4%), Turkey (28.4%) and Saudi Arabia (49.1%) (17,18). Our study shows that 38.1% of the participants agreed that AI presented no limitations on their work, of which students/undergraduates tended to disagree more than those with professional working experience as dentists ($p = 0.001$). We argue that this concern could come with work experience or the lack thereof, as medical practitioners understand the difficulty in complete AI replacement for many reasons raised by clinicians, such as patient–practitioner communication, empathy, trust and data security and privacy ethics. Existing literature reports that although medical practitioners cannot be replaced entirely by AI, they can be replaced by those who are well versed and capable of working with AI and advanced technology, emphasising the importance of AI education and application in dentistry. The participants in our study recognised the importance of AI learning, as they agreed that dentists' curricula should inculcate basic AI (78.4%). In this study, 61.9% and 76.1% agreed that AI should be taught in undergraduate and postgraduate programmes, respectively. The interest in learning AI is shown in the present study and previous studies, such as in Turkey [20], where 79.8% and 74.6% agreed that AI should be included in undergraduate and postgraduate curriculum, respectively. The participants stated the difficulty in finding appropriate education or courses to train in AI (25%), developing AI skills (23%) and graduates not being taught AI at university (17%) as the challenges of implementing AI at work. Moreover, only 14.8% of the participants had attended AI-related courses, indicating the repercussions of the lack of basic AI education in dental curricula going as far as impacting its implementation at work.

The future integration of AI in dental practice is seen differently by dentists and dental students. While many healthcare professionals assert that artificial intelligence can pave the way for a bright future in the sectors of health, others think AI is unstable and will never be able to replace healthcare professionals [13,14].

The disparity in the view of the impact of AI on the profession, according to our study, is between students and those with work experience of over 1 year. The previous study showed that AI could benefit dentists and make their services efficient. Hence, we argue that AI's awareness, limitations and benefits could be taught appropriately and emphasise the importance of incorporating AI training

courses related to dentistry for professionals [21].

5. Conclusions

With the use of cutting-edge technologies and AI healthcare sectors are at a turning point. AI and machine learning are increasingly important for creating prescriptive and predictive analytics, and AI-enabled software is revolutionizing the healthcare sector by bringing down costs and boosting effectiveness across the board [22]. AI integration policy should be developed to determine the ethical and regularity requirements, define the main roles and responsibilities of dentists. The policy will improve the interaction, communication between the vendors, stockholders (dentists) and scientific community. The educational and skills needed for dental undergraduate and postgraduate students should to be defined and ready to prepare students for implications of AI in their future practice. The current study highlighted the importance of integrating AI into curriculum, courses syllabus and clinical practice.

5.1. Recommendation

More research should be conducted with a large participant pool to understand attitudes toward artificial intelligence. Analysis of the current AI application available in practice and future demands will be useful for both dentists and vendors. Analysis of the current AI in the field of education and explore the future research challenges.

5.2. Limitations

There is a shortage of literature on the topic, which limits the scope of the current study. Open and focus group discussions can improve the survey 's closed-ended structure. To further understand the effects of AI on dental practice, a prospective study will be conducted to identify the necessary and available educational materials.

Author contribution statement

Mohamed Abuzaid, Zuhal Hamd: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Wiam Elshami: Conceived and designed the experiments, reviewed the paper.

Sausan Al Kawas and Hanan Aljuaid: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Data availability statement

No data was used for the research described in the article.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:Zuhal Hamd reports financial support was provided by Princess Nourah bint Abdulrahman University. No relationship or conflict of interest

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