

# Perceptions and Knowledge of Undergraduate Dental Students about Artificial Intelligence in Dental Schools: A Cross-sectional Study

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## ABSTRACT

**Objective:** This study aims to assess the perceptions and knowledge of undergraduate dental students about artificial intelligence (AI) in dental schools through a cross-sectional study.

**Materials and methods:** This was a multicenter, cross-sectional study. Participant recruitment was achieved by sending an online questionnaire to the undergraduate students at the assigned universities. The questionnaire consisted of two parts. The first seven questions record general information about participants and their perceptions of AI. The remaining questions are about the knowledge of participants about the applications of AI. The data were analyzed using SPSS version 26.

**Results:** About 165 undergraduate students from 20 universities related to the dental sciences responded to the questionnaire. And 80.6% of participants found the use of AI in dentistry exciting. I have a basic knowledge of the working principles of AI. About 80.6% of participants believe that applications of AI should be part of undergraduate dental training. And 66.6% of students are aware of the opportunities and threats that AI can create. The results show that 75% of the students indicated that they got their information about AI through social media. Regarding the association of years of studies with AI applications used in periodontics, the knowledge about AI applications in "aggressive periodontics," "compromised teeth," and "success in rate of dental implant" was significantly higher in senior students than junior students ( $p < 0.05$ ). Concerning applications of AI used in restorative dentistry and prosthodontics, only "computer color matching," "tooth surface losses," and "I do not know" showed statistical significance ( $p < 0.05$ ) with the year of study of participants. Senior students show significantly better knowledge in "success in retreatment" and "working length determinant."

**Conclusion:** Although undergraduates are enthusiastic about AI and aware of its threats and benefits, their knowledge is limited. In addition, undergraduate programs must exert more effort to prepare students for the era of AI.

**Keywords:** Artificial intelligence, Enthusiastic about AI, Perceptions and knowledge, Threats and benefits, Undergraduate students.

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## INTRODUCTION

Artificial intelligence (AI) is a widely discussed subject. It has a significant impact on health care and plays a crucial role in current technology advancements.<sup>1</sup> Deep learning systems, which have been recently established, are utilized for a range of therapeutic applications in the field of AI. They demonstrated high efficacy in utilizing image-based automated diagnosis across various domains, including lung cancer detection, age estimation of skeletal remains, cavity diagnosis, denture shade selection, removable partial design, temporomandibular disorder (TMD) treatment, orthodontic alignment, root morphology analysis, periodontal disease assessment, oral cancer identification, and periapical lesion detection.<sup>2</sup> As future systems advance, they are anticipated to become increasingly autonomous, going beyond just advising therapeutic actions to independently perform specific activities, such as conducting patient trials.<sup>3,4</sup> Owing to the profusion of information, medical students currently have challenges in meeting their educational obligations, prompting the widespread adoption of immersive and AI-driven solutions to augment medical teaching.

Utilizing AI in dentistry education has the potential to significantly influence both the theoretical knowledge and practical/clinical proficiency required for delivering dental healthcare. Lin

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et al. investigated the perspectives of accomplished undergraduate dentistry students on dental materials science. Contemporary technology has the potential to enhance several learning processes, such as "memorization and repetition," "collaborative learning," "resource exploration," "study organization," "classroom engagement," and "utilization of mnemonic techniques." Given

the rapid evolution of healthcare and advancements in teaching and learning methodologies, it is imperative to update the foundational dentistry education curriculum to incorporate AI. By incorporating the dental AI core curriculum, dentists can enhance their understanding of AI and develop the skills necessary to assess and utilize AI technology effectively.<sup>5</sup>

The utilization of AI in dentistry is rapidly advancing, and the acceptance of its implementation depends on the applications, making it difficult to accurately anticipate the timing. Nevertheless, AI will have a substantial impact on the future of dental education. The consequences will be inevitable and will likely vary depending on the specific application of AI in clinical and academic contexts. The implementation of AI in dentistry may result in the following alterations: The prioritization lies in training dentistry students to utilize and evaluate diagnostic tools that are based on AI.<sup>6</sup>

Artificial intelligence represents a notable breakthrough in the field of medicine, with applications that also encompass the digitization of dental practices. Artificial intelligence is programmed to mimic, expand upon, and utilize the foundational knowledge it has been trained on, in order to process new input. Medical students do not have concerns about being replaced by AI. However, for many students, the fear of being “displaced” discourages them from pursuing a certain medical specialty.<sup>7,8</sup> There exist both hopeful and pessimistic viewpoints regarding the influence of AI on individuals’ daily lives. An unfavorable perspective on AI foresees its displacement of humans across various fields. Nevertheless, proponents of AI argue that individuals that endorse this technology will have enhanced prospects to reap the rewards of forthcoming advancements.<sup>9</sup>

Moreover, a competition has commenced to create AI apps in order to address the growing difficulties of delivering efficient medical care in an age of excessive information. With the rapid increase in the number of studies utilizing digital technology, it is evident that a comprehensive understanding of various virtual worlds and their potential in addressing the aforementioned issues is imperative.<sup>10,11</sup>

To the authors’ knowledge, there are few studies on the opinions and attitudes of Saudi undergraduate dental students regarding the use of AI in dental care. Therefore, dentists must be prepared to utilize AI as a resource for these alterations. In order to address this issue, this cross-sectional study will evaluate the perceptions and knowledge of undergraduate dental students regarding AI in Saudi Arabian dental schools.

## MATERIALS AND METHODS

This study was approved by the Scientific Research Ethical Committee of Najran University, Saudi Arabia, with reference number: 010692-023520-DS.

The duration of this study was a cross-sectional study for 4 months. The targeted population in this study was undergraduate dental students in Saudi Arabia. An online survey was distributed among the undergraduate dental students in Saudi Arabia. The estimated sample size was 300 students. Sample population was enrolled as undergraduate students in either a public or private dentistry school in Saudi Arabia. The online questionnaire was circulated using email, Telegram, and WhatsApp platforms. The period that was kept open for the participants to respond was 4 months.

The total number of questions in the questionnaire was 15. All questions were constructed in English. The main questionnaire was divided into two parts. The first part consisted of 10 questions to

record general information about participants and their perceptions of AI. The perception of the participant was scored based on the Likert scale. The questions in the second part were about the knowledge of participants about the applications of AI, which consists of five questions. The questionnaire was validated by three professionals in dentistry and community medicine.

All the questions were posed in a multiple-choice format. All participants were provided with information about the research study in the invitation email. Consent was obtained from all participants in the first part of the online survey. Also, they were informed that “the findings of this investigation will be applied to scientific projects. You can drop out at any time. The data will be saved electronically on the university PC of the primary investigator and deleted in a year.”

The collected data were analyzed using descriptive as well as inferential statistics. A Chi-square was employed to determine the association between the year of study and the responses. The data were analyzed using SPSS (26, Chicago, Illinois, USA).

## RESULTS

One hundred sixty-five students from 20 universities related to dental sciences responded to the questionnaire. The response rate was 53.3%.

Only the respondents from King Khalid University and Najran University were sizeable, while the respondents from the remaining 18 universities were in single digits only. Therefore, those 18 universities were merged together as “other universities” (Fig. 1). Ninety-four respondents (57%) were students in their 5th year. Since 2nd- and 3rd-year students were quite insignificant in numbers, the 1st- and 2nd-year students were merged together, and 3rd- and 4th-year students were also combined for further analysis (Fig. 1).

Participants were enthusiastic about the AI. However, their basic knowledge was low. Figure 2 illustrates the responses of the participants about their excitement and basic knowledge of AI.

Forty-five percent of the applicants were dissatisfied with the availability of AI training at the dental school. About 80% of them believed that AI should be incorporated into the dental curriculum. Figure 3 exhibits their perspective on AI training and the incorporation of AI into the dental curriculum.

And 66.4% of respondents were aware of opportunity-driven conduct and AI-related threats. A total of 40.6% believed that AI would not replace dentists. Figure 4 represents the participants’ thoughts on the awareness of opportunities and the threats and probability of AI replacing dentists. Also, the majority of participants know about AI through social media (Fig. 5).

In response to the question of which dental specialty has been most influenced by applications of AI, one-third (33.9%) of the students mentioned prosthodontics, while only 3.6% of respondents showed oral medicine (Fig. 6).

Table 1 presents the association of the year of study with the responses of excitement in using AI, basic knowledge of AI, application of AI in undergraduate programs, opportunities in AI, and replacement of dentists by AI. None of these questions showed any statistical significance for the year of study.

Sources of information about AI categorized by respondents’ years of study are discussed in Table 2. Seventy-eight percent ( $n = 128$ ) of the students indicated that they got their information through social media. The least of the sources (14%) was shown by

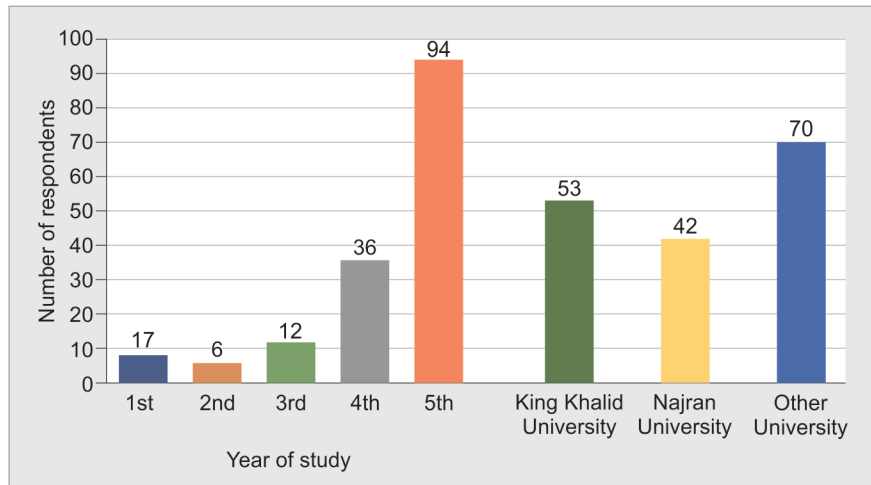


Fig. 1: Number of respondents categorized by year of study and university

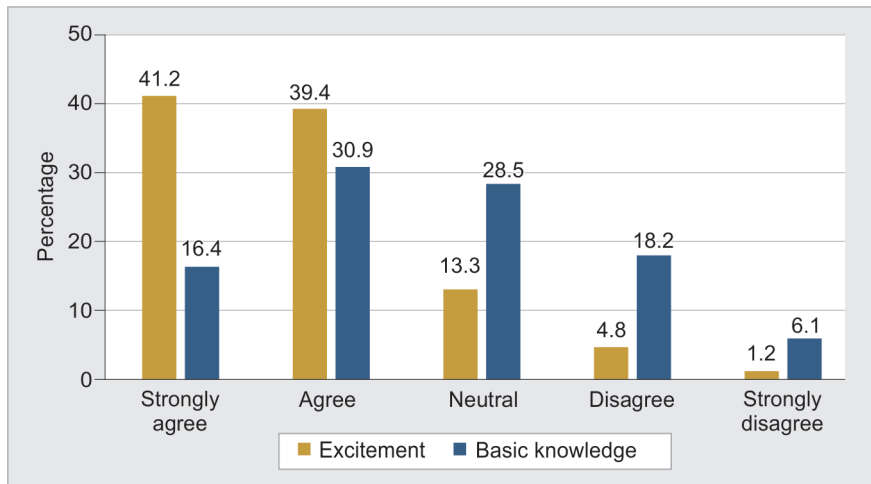


Fig. 2: Undergraduate students' excitement and basic knowledge of AI

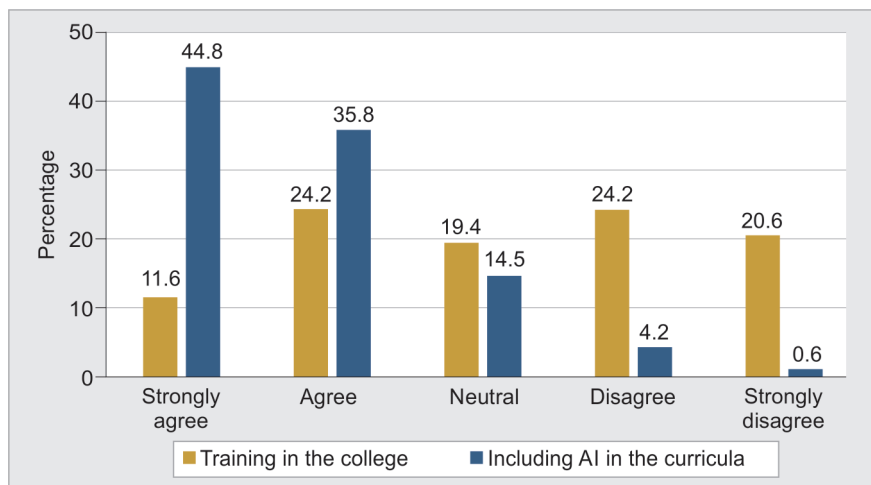


Fig. 3: Responses on AI training and the including of AI into the dental curricula

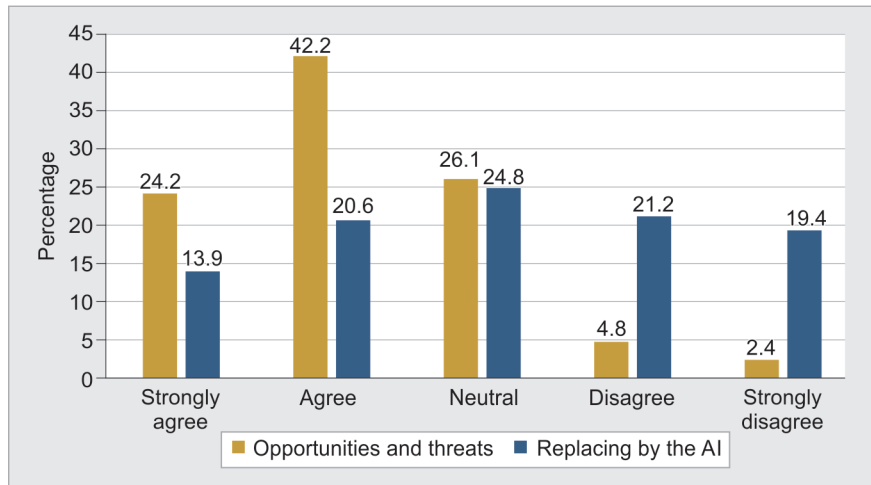


Fig. 4: Awareness of the opportunities and threats of AI and the replacement of dentists by AI

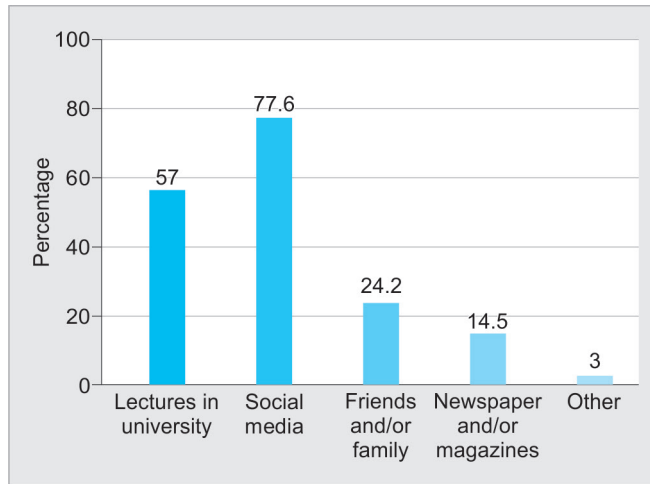


Fig. 5: Sources of information about artificial intelligence applications

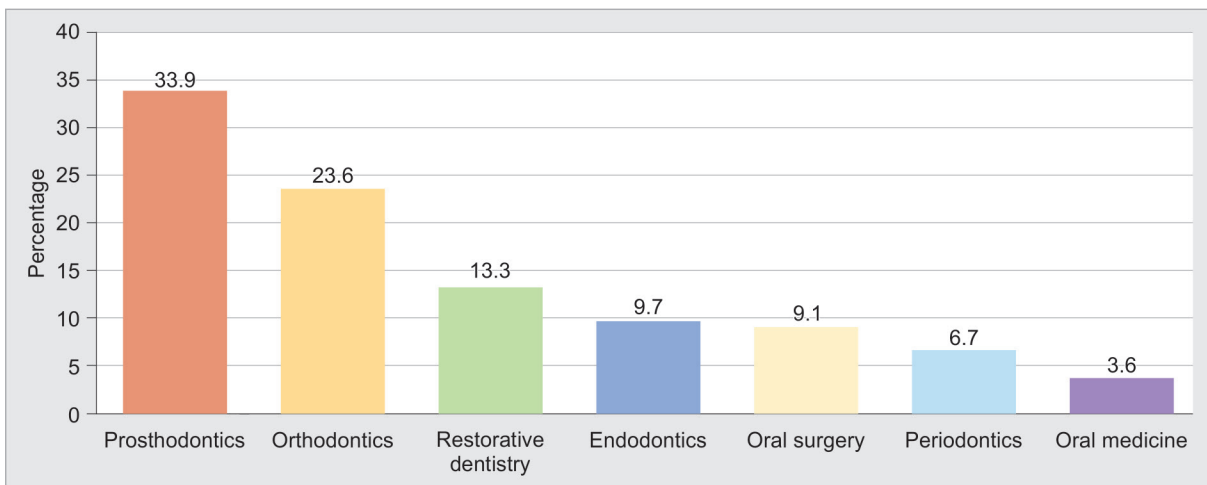


Fig. 6: Influence of AI application in dental specialties

**Table 1:** Association of year of study with excitement, basic knowledge, application in undergraduate programs, opportunities and replacement of dentists by AI

	<i>1st and 2nd year</i>	<i>3rd and 4th year</i>	<i>5th year</i>	<i>p-value</i>	<i>Total</i>
	<i>n (%)</i>	<i>n (%)</i>	<i>n (%)</i>		<i>n (%)</i>
<b>AI exciting</b>					
Agree	18 (14)	35 (26)	80 (60)	0.191*	133 (81)
Neutral	3 (14)	11 (50)	8 (36)		22 (13)
Disagree	2 (20)	2 (20)	6 (60)		10 (6)
<b>AI basic knowledge</b>					
Agree	8 (10)	21 (27)	49 (63)	0.615	78 (47)
Neutral	8 (17)	14 (30)	25 (53)		47 (28)
Disagree	7 (18)	13 (33)	20 (50)		40 (24)
<b>Application in undergraduate programs</b>					
Agree	19 (14)	36 (27)	78 (59)	0.694*	133 (80)
Neutral	3 (13)	8 (33)	13 (54)		24 (15)
Disagree	1 (13)	4 (50)	3 (37)		8 (5)
<b>Opportunity in AI</b>					
Agree	14 (13)	34 (31)	62 (56)	0.554*	110 (67)
Neutral	8 (19)	9 (21)	26 (60)		43 (26)
Disagree	1(8)	5 (42)	6 (50)		12 (7)
<b>Replace the dentists</b>					
Agree	9 (16)	16 (28)	32 (56)	0.424	57 (35)
Neutral	2 (5)	13 (32)	26 (63)		41 (25)
Disagree	12 (18)	19 (28)	36 (54)		67 (41)
Total	23 (14)	48 (29)	94 (57)		165

\*Chi-square assumption is violated

“Newspapers and Magazines.” None of the sources of information were significantly different between the years of study.

Table 3 illustrates the association of years of studies with AI applications used in periodontics. Fifth-year and (3rd and 4th)-year’s students had better knowledge than the 1st and 2nd-year’s students. The knowledge about AI applications in “aggressive periodontics,” “compromised teeth,” and “success in rate of dental implant” was significantly higher in senior students (3rd to 5th year) than junior students (1st and 2nd year) ( $p < 0.05$ ). The application of AI used in restorative dentistry and prosthodontics, categorized by year of study, is shown in Table 4. Questionnaire indicated the option of “dental caries on radiographic,” “restorative material was suitable or not,” “change of color after whitening,” planning for broken tooth,” computer color matching, “tooth surface losses”, and “I do not know.” Only “computer color matching,” “tooth surface losses,” and “I do not know” showed statistical significance ( $p < 0.05$ ) with the year of study.

Table 5 presents the association of AI applications used in oral medicine and pathology with the year of study. The senior students (3rd to 5th year) showed significantly better knowledge in “recurrent,” “aphthous ulceration,” and “diagnosed of TMD” as compared with junior students (1st and 2nd year). The association of AI application in endodontics with the year of study is discussed in Table 6. Again, senior students showed significantly better knowledge in “success in retreatment” and “working length determinant,” while “I do not know” had a significantly higher frequency in junior students.

It could be inferred that although undergraduate students demonstrate passion for AI and possess a basic grasp of its possible threats and benefits, their fundamental comprehension of the subject is inadequate.

**Table 2:** Association of year of study with source of information regarding AI

	<i>1st and 2nd year</i>	<i>3rd and 4th year</i>	<i>5th year</i>	<i>p-value</i>	<i>Total</i>
	<i>n (%)</i>	<i>n (%)</i>	<i>n (%)</i>		<i>n (%)</i>
<b>Source of information about AI</b>					
Friends and/or family	5 (22)	10 (21)	25 (27)	0.717	40 (24)
Lectures in University	10 (44)	32 (67)	52 (55)	0.161	94 (57)
Newspapers and magazines	3 (13)	10 (21)	10 (11)	0.250	23 (14)
Social media	18 (78)	36 (75)	74 (79)	0.878	128 (78)

**Table 3:** Association of year of study with the options of AI application used in periodontics

	<i>1st and 2nd year</i>	<i>3rd and 4th year</i>	<i>5th year</i>	<i>p-value</i>	<i>Total</i>
	<i>n (%)</i>	<i>n (%)</i>	<i>n (%)</i>		<i>n (%)</i>
<b>AI application used in periodontics</b>					
Aggressive periodontists	3 (13)	15 (31)	39 (42)	0.031	57 (35)
Oral hygiene behavior	3 (13)	16 (33)	30 (32)	0.167	49 (30)
Periodontal diseases	6 (26)	18 (38)	42 (45)	0.242	66 (40)
Compromised teeth	6 (26)	20 (42)	51 (54)	0.037	77 (47)
Rate of dental implant	5 (22)	19 (40)	55 (59)	0.003	79 (48)
I do not know	10 (44)	10 (20)	12 (13)	0.004	32 (19)

**Table 4:** Association of year of study with AI application used in restorative dentistry and prosthodontics

	1st and 2nd year	3rd and 4th year	5th year	<i>p</i> -value	Total
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)		<i>n</i> (%)
Application of AI used in restorative dentistry and prosthodontics					
Dental caries on radiographic	8 (35)	29 (60)	56 (60)	0.079	93 (56)
Restorative material is suitable	6 (26)	21 (44)	37 (39)	0.355	64 (39)
Change of color after whitening	4 (17)	19 (40)	36 (38)	0.139	59 (36)
Planning for broken tooth	3 (13)	16 (33)	30 (32)	0.167	49 (30)
Computer color matching	5 (22)	30 (62)	49 (52)	0.005	84 (51)
Tooth surface loss	3 (13)	17 (35)	38 (40)	0.048	58 (35)
I do not know	8 (35)	5 (10)	11 (12)	0.012	24 (15)

**Table 5:** Association of year of study with AI application used in oral medicine and pathology

	1st and 2nd year	3rd and 4th year	5th year	<i>p</i> -value	Total
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)		<i>n</i> (%)
AI application in oral Medicine and pathology					
Classification of oral malodor	4 (17)	19 (40)	33 (35)	0.170	56 (34)
Recurrent aphthous ulceration	3 (13)	22 (46)	35 (37)	0.026	60 (36)
Detection of TMD	8 (35)	20 (42)	47 (50)	0.347	75 (46)
Diagnosis of TMD	3 (13)	23 (46)	43 (46)	0.010	69 (42)
Diagnosis of progression of TMDs	7 (30)	23 (48)	48 (51)	0.205	78 (47)
I don't know	10 (44)	11 (23)	19 (20)	0.064	40 (24)

**Table 6:** Association of year of study with AI application used in endodontics

	1st and 2nd year	3rd and 4th year	5th year	<i>p</i> -value	Total
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)		<i>n</i> (%)
AI application used in endodontics					
Periapical lesions and vertical root function	10 (44)	32 (66)	51 (54)	0.150	93 (56)
Success of retreatment	3 (13)	23 (48)	53 (56)	0.001	79 (48)
Working length determinant	7 (30)	34 (71)	66 (70)	0.001	107 (65)
I do not know	12 (52)	8 (17)	16 (17)	0.001	36 (21)

## DISCUSSION

It is unavoidable that AI will have a significant influence on the next generation of medical and dental practitioners. Concerns about the future of professionals' careers in the era of AI, particularly radiologists, have begun to be discussed.<sup>12</sup> On the other hand, this statement is not supported by scientific evidence; there is a lack of cross-sectional studies conducted among undergraduate dental students on their perceptions and knowledge of AI in dentistry. Accordingly, this study aims to assess the perceptions and knowledge of undergraduate dental students about AI in dental schools through a cross-sectional study.

Unsurprisingly, the results indicate that most of the dental students are interested in AI, but their basic knowledge about the main principles of using AI does not reflect their levels of interest. Similar results were revealed in Turkish students.<sup>9</sup> Their literacy of the basics of AI could be a sign that their excitement was based on the evolution of AI, not on their

academic background or clinical needs. The literacy of AI was confirmed by the fact that most participants believed that most of the AI software influenced clinical modalities more than diagnostic procedures. Most of the students were not satisfied with AI training in the dental school, and 80% of them believed that AI should be included in the dental curricula. With the fast growth of AI software and applications, stockholders in the academic sector need to take action to train students on AI in undergraduate training. Accordingly, revising dental curricula and implementing the basic knowledge of AI could be demanded. Though they are excited by the use of AI in dentistry, respondents did not agree that AI could replace themselves in the near future, as in a Korean study.<sup>4,13</sup> The Korean study has 669 physician respondents. About 5.9% of them state that they knew AI well. Most of the participants (83.4%) agreed that AI was useful in medicine. Participants worried that AI would not help in unforeseen situations due to a lack of information (29.3%).

Only 43.9% agreed that AI is better at diagnosing than humans. One-third of respondents reported that AI could replace their occupations. Such recommendations should be analogous with transformations in Saudi Arabia according to Vision 2030. Digitalization is one ultimate reform, along with a major shift to a new model of health care. This makes AI knowledge, perception, and readiness extremely significant.<sup>14-16</sup> The results of this study agree with the previous study conducted on medical and dental students, although the dental undergraduate students in the previous study were only 20%. Aboalshamat et al. studied the Saudi medical and dental professions' readiness for AI. A cross-sectional survey of 334 Saudi medical and dental students and practitioners. Dental professionals scored higher on AI readiness than participants. Dental professionals scored higher on AI readiness than medical participants. Saudi medical and dentistry students should receive AI material and hands-on training during their undergraduate and postgraduate studies. The authors stated that future studies are needed with larger sample sizes of dental professionals to provide external validity.<sup>17</sup> In contrast to various other occupations, it becomes apparent that the replacement of medical professionals and dentists by AI applications will pose significant challenges. The challenges that may hinder the replacement of dentists include the AI's limited ability to establish trust with patients, as seen by its weak engagement in professional conversations, failure to provide reassurance, and lack of empathy towards patients. Furthermore, while AI gathers important data to aid in the process of diagnosis, the presence of healthcare experts is essential for the purpose of interpreting information in unclear circumstances, incorporating medical history, doing physical assessments, and fostering meaningful conversations with patients.<sup>18,19</sup> The participants also observed that social media platforms offer a greater amount of knowledge compared to academic sources, a finding that aligns with expectations. The available sources of information provide evidence of a notable transition within the current generation, wherein there is an apparent move away from traditional print media toward electronic media platforms. Social media can help to explain the main source of AI. However, it is concerning that students' inadequate basic knowledge and limited exposure to AI may lead them to depend on untrusted or unverified software for medical diagnosis and treatment. The senior students demonstrated a notable level of proficiency in AI applications in various specialized areas, including aggressive periodontitis, TMD diagnosis, and the success of root canal retreatment. The authors believed it to have more statistical significance compared with the significance of perception and attitude as a result of the impact of clinical attachment and clinical exposure in the training. It is important to acknowledge that this study has certain limitations. The poll was conducted exclusively among a limited number of Saudi universities, resulting in a relatively small sample size. Furthermore, it is possible that the participants recruited may not have adequately represented the whole population of dentistry students. Furthermore, it should be noted that our analysis just focused on the perspective of undergraduate dental students. Consequently, it is plausible to argue that graduate students, residents, and more experienced dentists may not hold the same optimistic viewpoints as the

mentioned students. Finally, the questionnaire was devised by health care professionals rather than AI professionals.

## CONCLUSION

While undergraduate students exhibit enthusiasm for AI and possess a general awareness of its potential risks and advantages, their fundamental understanding of the topic remains poor. Undergraduate programs should prioritize the integration of AI into their curricula and enhance their efforts to equip students with the necessary skills and knowledge to thrive in the age of AI.

## DISCLOSURE

The authors do not have any financial interest in the companies whose materials are included in this article.

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