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Knowledge, attitudes, and perceptions of dental students towards artificial intelligence in Riyadh, Saudi Arabia

Sanjeev Khanagar[1,2,3], **Mohammad Alkathiri**[1], **Rakan Alhamlan**[1], **Khalid Alyami**[1], **Majed Alhejazi**[1], **Ahmed Alghamdi**[1]

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Author Affiliation:
[1]College of Dentistry, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia
[2]King Abdullah International Medical Research Center, Riyadh, Saudi Arabia; Email: - khanagars@ksau- hs.edu.sa
[3]Preventive Dental Science Department, College of Dentistry, King Saud bin Abdulaziz University for health Sciences, Riyadh, Saudi Arabia

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ABSTRACT

Introduction: The pace of advancement of artificial intelligence (AI) in dentistry is accelerating rapidly. Thus, it's very difficult for individuals to conclude that they can fully understand it. The aim of this study was to assess the knowledge, attitudes, and perceptions of dental students in Riyadh, Saudi Arabia towards (AI). *Materials and Methods*: A cross-sectional study was conducted using an online-based questionnaire sent to dental students in Riyadh, Saudi Arabia. The questionnaire used in this study was Google Forms. Furthermore, it was developed after referring a pre-validated questionnaire and distributed to students through social media platforms. The data collection was after 3 weeks. *Results*: Out of 423 participants, 50.1% had no basic knowledge about the working principle of AI. Also, the majority was not aware of the usage of AI in dentistry (55.8% No). The students get their knowledge about AI from social media and it was the most chosen answer by 40.9% (n=324). When questioned about whether AI applications should be part of undergraduate or postgraduate dental training, the agreement response was higher in postgraduate training (48.9%; n=207) compared to the undergraduate training (40.4%; n=171). *Conclusion*: Despite the fact that the knowledge of AI among dental students was considered to be low, dental students were enthusiastic to learn more about new technologies related to dentistry. Also, participants believed that AI will play a vast role in dentistry. In order to improve the dental students' knowledge about AI, lectures, curricular courses, and scientific meetings should be highly considered.

Keywords: Artificial intelligence, Attitudes, Awareness, Dental student, Knowledge.

1. INTRODUCTION

Artificial Intelligence (AI) is considered one of the biggest breakthroughs in science and technology (Schwendicke et al., 2020; Yüzbaşıoğlu, 2020). AI has a lot of definitions, however, it's best defined by Kaplan and Haenlein as "the

system's ability to correctly interpret external data, to learn from such data, and to use them to achieve specific goals and tasks through flexible adaptations (Kaplan & Haenlein, 2018). Nowadays, the uses of AI are present everywhere in our daily life. Moreover, a lot of people are not aware that AI is present in most of the things they use of a daily basis. For instance, AI plays an important role in self-driving and parking vehicles. Other examples worth mentioning are smart replies in E-mails and smart maps which we use every day to reach our different destinations. Humans are the most intelligent creatures we know of; however, when we talk about pattern recognition, machines are considered better because they can use more dimensions of data and this is called machine learning (ML) (Schwendicke et al., 2020).

The human brain is a network of neurons, and those neurons help us to learn things (Schwendicke et al., 2020). Furthermore, if we can replicate the structure and function of the human brain we might get cognitive capabilities in machines and this called the field of neural networks (NN) (Schwendicke et al., 2020). Also, if these networks are more complex and deeper, and we use those networks to learn complex things this is called deep learning (DL) (Schwendicke et al., 2020). All of these advances in computer and informatics technologies have enabled the use of AI. Deep learning (DL) have been introduced to be used effectively in multiple fields for image-based automated diagnosis including lung cancer, colorectal polyps, prostate cancer, hip osteoarthritis, bone age assessment, caries diagnosis, color selection, removable partial denture design, temporomandibular disorders, orthognathic treatment, maxillary sinusitis, root morphology, periodontal diseases, oral cancer, periapical lesions, radiolucent lesions, cystic lesions, cephalometric analysis, and debonding of computer-aided design/computer-aided manufacturing (CAD/CAM) crowns. In the upcoming future, we can witness that those systems will work independently to perform tasks and actions. There are no published researches which has assessed the knowledge of dental students towards artificial intelligence in Riyadh, Saudi Arabia. Therefore, the aim of this study is to assess the knowledge, attitudes, and perceptions of dental students towards AI in Riyadh, Saudi Arabia.

2. METHODOLOGY

This cross-sectional study was conducted using an online-based questionnaire sent to dental students in Riyadh, Saudi Arabia. The ethical approval for this study (SP 21R/001/01/R) was obtained prior to commencing our study from the Institutional Review Board of the King Abdullah International Medical Research Centre (KAIMRC), Riyadh. The type of questionnaire used in this study was Google Forms. The aim of this study was to assess the knowledge, attitudes, and perceptions of dental students in Riyadh, Saudi Arabia towards artificial intelligence. The questionnaire was distributed to dental students through social media platforms such as Twitter, and WhatsApp. The data collection was done between September and October 2020. Also, the students were given in person a questionnaire barcode to scan. Moreover, the data collection was scheduled for a period of 3 weeks. The universities included in this study were: King Saud bin Abdulaziz University for Health Sciences, King Saud University, Alfarabi College Riyadh Elm University, Prince Sattam bin Abdulaziz University, Princess Nora bint Abdulrahman University, Dar Al Uloom University

Convenient sampling technique was carried out for a minimum sample size of 410, which was calculated using the following formula:

Expected Proportion = 0.484

Relative Precision (%) = 10

Desired confidence level (%)= 95

Required sample size = 410

Formula

$$n = \frac{\left(z^{2}_{1-\frac{\alpha}{2}}\right)(1-p)p}{\xi^{2}p}$$

Where,

p : Expected proportion

ξ : Relative precision

1- $\alpha/2$: Desired Confidence level

The questionnaire was developed after referring a pre-validated questionnaire (Yüzbaşıoğlu, 2020). The questionnaire which was sent to dental students was in English. The aim of the study was explained in the questionnaire. The questionnaire included 3 sections and 22 questions. The first part of the questionnaire included questions related to sociodemographic characteristics which were university name, age, gender, and grade of dental education. In the second part, the participants were asked 3 questions about (1) "information source of recent AI applications using in daily life," (2) "having a basic knowledge about the working principles of AI," and (3) "being aware of the usage of AI in dentistry." In the third section, the participants were presented with 15 statements and asked to indicate their level of agreement (disagree entirely, rather disagree, rather agree, or agree entirely). The data obtained from the questionnaire were entered into JMP (statistical software). Chi square analysis and multiple logistic regression analysis were calculated to measure the association of gender and university on their responses.

3. RESULTS

During conducting our study, we ended up with 423 dental students from Riyadh who completed the survey. 49.2% were female (n=208) and 50.8% were male (n=215). Most of the dental students were from King Saud bin Abdulaziz University for Health Sciences forming 42.1% (n=178) of the study, Then King Saud University with 20.3% (n=86), Riyadh Elm University 17% (n=72), Princess Nora bint Abdulrahman University 9.5% (n=40), Prince Sattam Bin Abdulaziz University 4.7% (n=20), Dar Al Uloom University 4% (n=17), and the least participation was from Alfarabi College 2.4% (n=10). As mentioned in Figure 1.

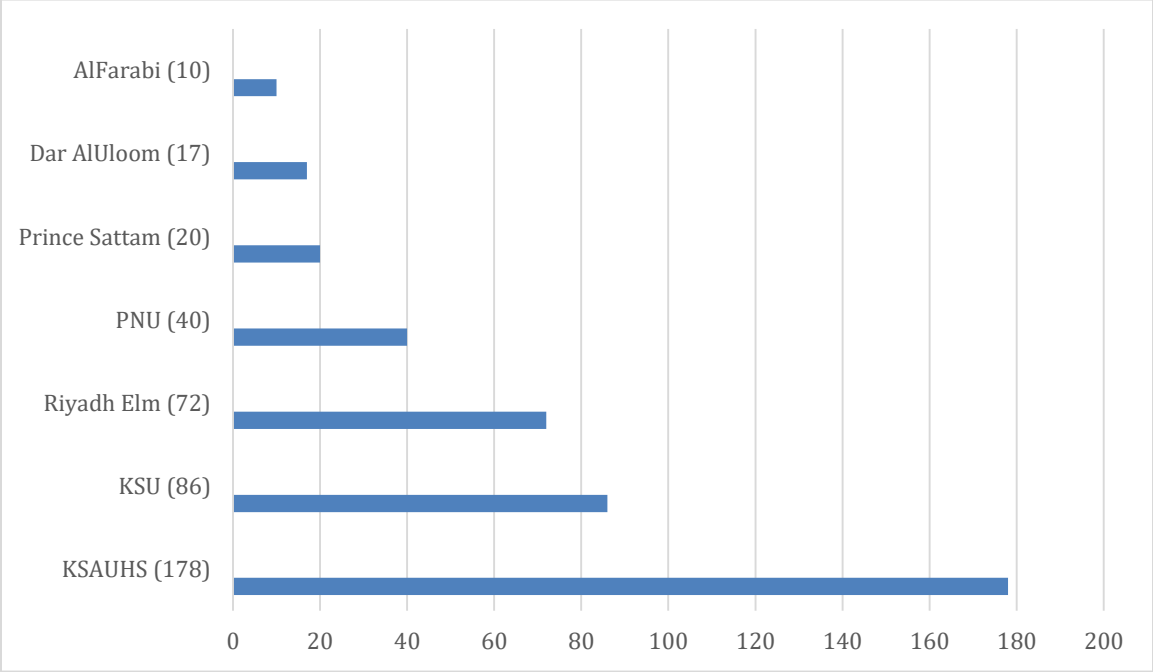

Figure 1 Distribution Based on University

Dental students who completed the survey that were in the 1st year was 6.9% (n=29), 9.7% (n=41) were 2nd year, 18.4% (n=78) were 3rd year, 13.2% (n=56) were 4th year, 25.1% (n=106) were 5th year, and 26.7% (n=113) were 6th year dental students (Figure 2).

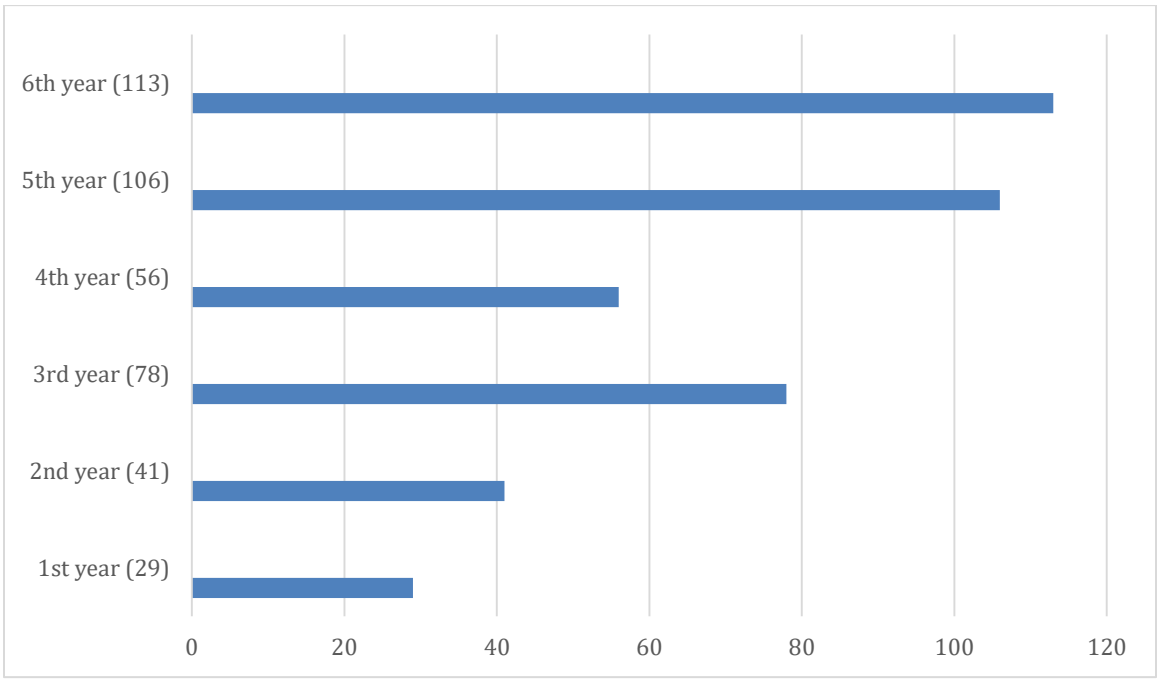

Figure 2 Distribution Based on Level of Education

In the survey, the dental students were asked where did they get their knowledge about AI and were given choices from social media (Facebook, Instagram, etc.) had the most percentage of 40.9% (n=324), friends and family which was 26% (n=208), lectures at their universities 20.8% (n=165), and the least percentage was newspapers and magazines 12% (n=95) (Figure 3).

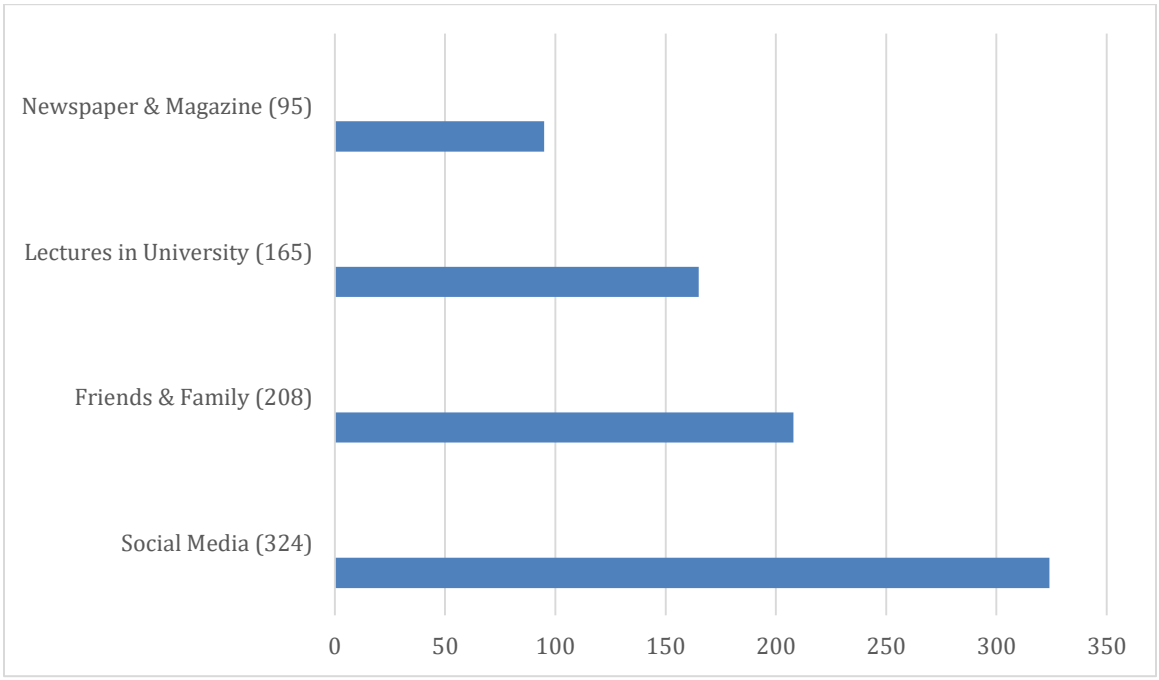

Figure 3 Distribution Based on Source of Information

The dental students who participated were split in half with a 0.1% difference when asked if they have basic knowledge about the working principle of artificial intelligence (50.1% No and 49.9% yes). Even though the majority was not aware of the usage of AI in dentistry (55.8% No and 44.2% yes). However, 46.8% (n=198) strongly agree that AI will lead to major advances in dentistry and medicine, on top of that 39.7% (n=168) agree with only 3.3% (n=14) disagree and there was 10.2% (n=43) had no idea and none chose to strongly disagree. Almost half (47.3%-n=200) of the participants agree that the use of AI in dentistry and medicine is exciting, 34% (n=144) strongly agree, and on the other hand, 2.4% (n=10) disagree and only 0.7% (n=3) strongly disagree with 15.6% (n=66) had no

idea. Also, the dental students who agree that AI can be used as a definitive diagnostic tool in the diagnosis of diseases were 37.6% (n=159) where as 16.5% (n=70) disagree.

Furthermore, 14.9% (n=63) strongly agree whereas 4.3% (n=18) strongly disagree. Surprisingly, 26.7% (n=113) had no idea. Just above half of the participants (50.4% n=213) agree on the capability of AI being used as a prognostic tool to predict the course of a disease and determine whether there is a chance of recovery, 16.3% (n=69) strongly agree. The minority disagrees and strongly disagrees (6.1% and 1.4%), whereas one fourth (25.8%) had no idea. When asked about the AI capability of diagnosing tooth caries on radiographs, almost half agree (49.6%-n=210). In addition, one fourth (25.1%-n=106) strongly agree. On the other hand, 18.7% (n=79) had no idea, 6.4% (n=27) disagree and only one person strongly disagrees which represents 0.2%. Also, when asked about periodontal diseases diagnosis in radiographs, almost half of the dental students 46.3% (n=196) agree and 20.8% (n=88) strongly agree. Whereas 8% (n=34) disagree, 0.9% (n=4) strongly disagree, and 23.9% (n=101) had no idea. The same idea goes for when asked if AI can be used in the diagnosis of soft tissue lesions of the mouth. Where 37.8% (n=160) agree, 17.7% (n=75) strongly agree, 9.9% (n=42) disagree, 3.3% (n=14) strongly disagree, and 31.2% (n=132) had no idea. We also found out that around half of the participants 44% (n=186) agree on the statement "AI can be used in 3D implant positioning and planning and above one third strongly agree 35.5% (n=150).

The dental students that had no idea were 17.5% (n=74) and only 3% disagree and strongly disagree (2.1%-n=9 and 0.9%-n=4) respectively. Regarding the use of AI as treatment planning tool in diagnosis and treatment planning in dentistry, the majority agree 4.2% (n=187) and who strongly agree are around one fourth 23.4% (n=99). Almost one fifth of the study group 20.6% (n=87) had no clue and the others shared the disagreement response by 8.3% (n=35) and strongly disagree by 3.5% (n=15). When asked if AI could be used as quality control tool to assess the success of treatments, just above 70% agree and strongly agree (51.3% - 19.6%) (n=217, n=83). While less than 7% answered with disagree and strongly disagree (4.7% - 2.1 %) (n=20, n=9) and the rest has no idea 22.2% (n=94). It was widely agreed that AI can be used in the radiographic diagnosis of pathologies in the jaws, 47.3% agreed (n=200) and 21.5% strongly agreed (n=91), on the other side, the disagreement was 6.9% (n=29) and the minority which is strongly disagree was 2.1% (n=9) while there is still a good portion of the group study who had no idea 22.2% (n=94).

However, when asked if AI could be used in forensic dentistry, the number of students who agrees is almost the same as the student who has no idea at all (38.8% - n=162 agree) and (36.2% - n=153 no idea). One fifth of the participants 20.1% (n=85) strongly agree. Those who disagree were 3.8% (n=16) and the strongly disagree were 1.7% (n=7) when comparing the responses of the students about whether AI applications should be part of undergraduate or postgraduate dental training. The agreement response was higher in postgraduate training (33.3% - n=141 strongly agree and 48.9% - n=207 agree) compared to the undergraduate training (26.7% - n=113 strongly agree and 40.4% - n=171 agree). As expected, the disagreement response was higher in undergraduate training (3.1% - n=13 strongly disagree and 8.7% - n=37 disagree) compared to the postgraduate training (0.9% - n=4 strongly disagree and 3.1% - n=13 disagree). Lastly, 21% of the students (n=89) do not have an idea whether to apply AI in undergraduate training, and 13.7% (n=58) has the same response for postgraduate training. As shown in Table 1.

Table 1 Distribution of the answers

		Frequency	Percent
Do you have the basic knowledge about the working principle of Artificial Intelligence?	No	212	50.1
	Yes	211	49.9
Are you aware of the usage of Artificial Intelligence in Dentistry?	No	236	55.8
	Yes	187	44.2
Do you consider artificial intelligence will lead to major advances in dentistry and medicine?	Agree	168	39.7
	Disagree	14	3.3
	No idea	43	10.2
	Strongly Agree	198	46.8
Do you think the use of artificial intelligence in dentistry and medicine is exciting?	Agree	200	47.3
	Disagree	10	2.4
	No idea	66	15.6
	Strongly Agree	144	34
	Strongly Disagree	3	0.7

Artificial intelligence can be used as a definitive diagnostic tool in the diagnosis of diseases.	Agree	159	37.6
	Disagree	70	16.5
	No idea	113	26.7
	Strongly Agree	63	14.9
	Strongly Disagree	18	4.3
Artificial intelligence can be used as a prognostic tool to predict the course of a disease and determine whether there is a chance of recovery.	Agree	213	50.4
	Disagree	26	6.1
	No idea	109	25.8
	Strongly Agree	69	16.3
	Strongly Disagree	6	1.4
Artificial intelligence can be used for radiographic diagnosis of tooth caries	Agree	210	49.6
	Disagree	27	6.4
	No idea	79	18.7
	Strongly Agree	106	25.1
	Strongly Disagree	1	0.2
Artificial intelligence can be used in the radiographic diagnosis of periodontal diseases.	Agree	196	46.3
	Disagree	34	8
	No idea	101	23.9
	Strongly Agree	88	20.8
	Strongly Disagree	4	0.9
Artificial intelligence can be used in the diagnosis of soft tissue lesions of the mouth.	Agree	160	37.8
	Disagree	42	9.9
	No idea	132	31.2
	Strongly Agree	75	17.7
	Strongly Disagree	14	3.3
Artificial intelligence can be used in 3-dimensional implant positioning and planning.	Agree	186	44
	Disagree	9	2.1
	No idea	74	17.5
	Strongly Agree	150	35.5
	Strongly Disagree	4	0.9
Artificial intelligence can be used as a treatment planning tool in diagnosis and treatment planning in dentistry.	Agree	187	44.2
	Disagree	35	8.3
	No idea	87	20.6
	Strongly Agree	99	23.4
	Strongly Disagree	15	3.5
Artificial intelligence can be used as a quality control tool to assess the success of treatments.	Agree	217	51.3
	Disagree	20	4.7
	No idea	94	22.2
	Strongly Agree	83	19.6
	Strongly Disagree	9	2.1
Artificial intelligence can be used in the radiographic diagnosis of pathologies in the jaws.	Agree	200	47.3
	Disagree	29	6.9
	No idea	94	22.2
	Strongly Agree	91	21.5
	Strongly Disagree	9	2.1
Artificial intelligence can be used	Agree	162	38.3

in forensic dentistry.	Disagree	16	3.8
	No idea	153	36.2
	Strongly Agree	85	20.1
	Strongly Disagree	7	1.7
Artificial intelligence applications should be part of undergraduate dental training.	Agree	171	40.4
	Disagree	37	8.7
	No idea	89	21
	Strongly Agree	113	26.7
	Strongly Disagree	13	3.1
Artificial intelligence applications should be part of postgraduate dental training.	Agree	207	48.9
	Disagree	13	3.1
	No idea	58	13.7
	Strongly Agree	141	33.3
	Strongly Disagree	4	0.9

4. DISCUSSION

In the present study, there were equal number of participants from both the genders, males 50.8% (215) and the females were 49.2% (208). Whereas a similar study conducted in Turkey (Yüzbaşıoğlu, 2020) the majority of participants in their study were females by 59% (650) and the males were 41% (453). Also, in another study conducted in Germany, it had 63.8% (166) female participants, which represented the majority, and the male participants were 36.2% (94). We can conclude that in our study it was distributed equally between both genders compared to the Turkish study (Yüzbaşıoğlu, 2020), and in the German study (Pinto et al., 2019), it was distributed to females more. 1st year dental students 6.9% (29) were the least to participate in this study. On the other hand, in the Turkish study (Yüzbaşıoğlu, 2020) it was the 6th year dental students who had the majority of participation 8.8% (97). Almost a split decision in the present study about having the basic knowledge of the working principle of AI (50.1% no and 49.9% yes) with only a one participant difference. As shown in Table 2 & 3.

Table 2 Association of different university on basic knowledge about the working principle of Artificial Intelligence.

University		Do you have the basic knowledge about the working principle of Artificial Intelligence?		P Value
		No	Yes	
Alfarabi College	N	6	4	0.068
	%	60.00%	40.00%	
Dar Al Uloom University	N	10	7	
	%	58.80%	41.20%	
King Saud bin Abdulaziz University for Health Sciences	N	89	89	
	%	50.00%	50.00%	
King Saud University	N	49	37	
	%	57.00%	43.00%	
Prince Sattam Bin Abdulaziz University	N	14	6	
	%	70.00%	30.00%	
Princess Nora bint Abdulrahman University	N	18	22	
	%	45.00%	55.00%	
Riyadh Elm University	N	26	46	
	%	36.10%	63.90%	

Table 3 Association of different Grade\Year of Dental Education on basic knowledge about the working principle of Artificial Intelligence

Grade\Year of Dental Education		Do you have the basic knowledge about the working principle of Artificial Intelligence?		P Value
		No	Yes	
1st Year	N	18	11	0.15
	%	62.10%	37.90%	
2nd Year	N	16	25	
	%	39.00%	61.00%	
3rd Year (D1)	N	38	40	
	%	48.70%	51.30%	
4th Year (D2)	N	34	22	
	%	60.70%	39.30%	
5th Year (D3)	N	56	50	
	%	52.80%	47.20%	
6th Year (D4)	N	50	63	
	%	44.20%	55.80%	

Even in the Turkish study (Yüzbaşıoğlu, 2020), they had a close response (51.6% no and 48.4% yes). However, in a study conducted on dental professionals in India, 68% were familiar with the concept of AI and its uses (Sur et al., 2020). It can be noticed that in our study and the Turkish study is almost equal in terms of having the basic knowledge of AI which could mean that this topic is not very popular in both communities. In the Indian study, they had higher knowledge which could explain that dental professionals were more aware about the concept of AI more than dental students in general (Sur et al., 2020). 58.8% (236) of the study participants in our study were aware of the usage of AI in dentistry (as shown in Table 4 & 5) while in the Turkish study (Yüzbaşıoğlu, 2020), 78.7% of the study participants reported that knowledge.

Table 4 Association of different university on the knowledge of usage of Artificial Intelligence in Dentistry

University		Are you aware of the usage of Artificial Intelligence in Dentistry?		P Value
		No	Yes	
Alfarabi College	N	5	5	0.017*
	%	50.00%	50.00%	
Dar Al Uloom University	N	7	10	
	%	41.20%	58.80%	
King Saud bin Abdulaziz University for Health Sciences	N	110	68	
	%	61.80%	38.20%	
King Saud University	N	55	31	
	%	64.00%	36.00%	
Prince Sattam Bin Abdulaziz University	N	12	8	
	%	60.00%	40.00%	
Princess Nora bint Abdulrahman University	N	16	24	
	%	40.00%	60.00%	
Riyadh Elm University	N	31	41	
	%	43.10%	56.90%	

Table 5 Association of different Grade\Year of Dental Education on the knowledge of usage of Artificial Intelligence in Dentistry

Grade\Year of Dental Education		Are you aware of the usage of Artificial Intelligence in Dentistry?		P Value
		No	Yes	
1st Year	N	21	8	0.001*
	%	72.40%	27.60%	
2nd Year	N	29	12	
	%	70.70%	29.30%	
3rd Year (D1)	N	49	29	
	%	62.80%	37.20%	
4th Year (D2)	N	45	11	
	%	80.40%	19.60%	
5th Year (D3)	N	52	54	
	%	49.10%	50.90%	
6th Year (D4)	N	40	73	
	%	35.40%	64.60%	

On the contrary, in the Indian study, 42% had a basic understanding of how to integrate AI into dentistry (Sur et al., 2020). Essentially, in our study and the Indian study, the majority has not heard about the uses of AI in dentistry which could be due to the lack of workshops, conferences and curricular lectures related to AI. In the other hand, in the Turkish study, participants had more workshops and scientific conferences related to the uses of AI in dentistry. When asked if AI can be used as a treatment planning tool in diagnosis in dentistry, the most response from the students was agree by having 44.2% (187), in the Turkish study, similarly, agree was the most chosen response by 57.2% (631), and in the Indian study, 72% (181) of the participants agreed that AI can be utilized in treatment planning. When questioned about if the use AI in dentistry and medicine is exciting, 47.3% (200) in the present study and 51% (562) in the Turkish (Yüzbaşıoğlu, 2020) study agreed that AI can be an exciting tool to use. Surprisingly, 38.4% (101) of the study participants from the study conducted in Germany (Pinto et al., 2019) disagreed, which could be due to that the German study (Pinto et al., 2019) participants do not have the excitement to use AI in their practice and are afraid of being replaced by technology. When asked about the sources of getting AI information, in our study, we found out the dental students in Riyadh mostly got their information about AI was from social media platforms by 40.9% (324). The same applied for the Turkish study (Yüzbaşıoğlu, 2020) by 76.1% (839).

In all of the studies, the participants have heard about AI in social media since almost everyone nowadays has a smart phone, and almost everyone is using social media. Also, AI concepts and uses are being posted frequently in social media. In our study and the Turkish study (Yüzbaşıoğlu, 2020), the majority of participants have not heard about AI from magazines or newspapers since it is becoming a decreased source of information in both communities. In the other hand, in the German study (Pinto et al., 2019), the majority of study participants have heard about AI from newspapers and magazines which could explain that the population is still using the traditional way to get their daily information.

In the present study, 46.8% of the study participants strongly agreed that AI will lead to major advances in dentistry and medicine, whereas in Turkey (Yüzbaşıoğlu, 2020) and Germany (Pinto et al., 2019) only (46.5% and 56.3%) agreed. In our study, only 37.6% of the study participants agreed that AI can be used as a definitive diagnosis tool in the diagnosis of diseases which indicates that the students are aware of AI, but the basic knowledge about its uses and working principles is low. While the conducted study in Turkey (Yüzbaşıoğlu, 2020), the participants disagreed by 36.1%. Our study and the Turkish study (Yüzbaşıoğlu, 2020) participants both agreed on AI can be used as a prognostic tool to predict the course of a disease and determine whether there is a chance of recovery. Also, our study and the Turkish study (Yüzbaşıoğlu, 2020), agreed on that AI can be used for radiographic diagnosis of tooth caries. Similarly, both studies participants agreed when asked if AI can be used for radiographic diagnosis of periodontal diseases.

Furthermore, when surveyed if AI can be used in the diagnosis of soft tissue lesions of the mouth, the present study participants agreed by 37.8% (160), and the Turkish study (Yüzbaşıoğlu, 2020) participants also agreed by 54.7% (603). Moreover, both studies agreed that AI can be used in 3D implant positioning and planning. When asked If AI can be used as a quality control tool to assess the success of treatments, both studies respondents agreed that AI is beneficial in this subject. Likewise, participants were asked if

AI can be used in the radiographic diagnosis of pathologies in the jaws, both studies respondents agreed. After that, in the present study, respondents were questioned if AI can be used in forensic dentistry. Agree was the most answer chosen by 38.3% (162). Similarly, in the Turkish study, the participants agreed that AI can be used in forensic dentistry by 52.1% (575) (Yüzbaşıoğlu, 2020). Participants were asked if AI applications should be part of undergraduate dental training, and the result to this question was agreed in our study and the Turkish study (Yüzbaşıoğlu, 2020). The reason could be that undergraduate dental students are keen to learn new technologies related to dentistry which could increase the success of the treatment.

Lastly, the present study and the Turkish study participants both agree that AI applications should be part of postgraduate dental. The reason could be that the graduated students would like to learn this technology so they can apply it in their dental practice.

5. CONCLUSION

The present study revealed that the dental students in Riyadh, Saudi Arabia are excited to use artificial intelligence technology in their near future and hope it will help them with their treatment and diagnosis. In order to reach that expectation, more surveys on this topic should be carried out to investigate more and conferences about AI in dentistry should be held more often. Dental academic curriculums should include more lectures about this topic to enlighten the dental students of the uses of AI in their daily practice.

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Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study.

Conflict of Interest

The authors declare that there are no conflicts of interests.

Ethical approval

The study was approved by the Medical Ethics Committee of King Saud bin Abdulaziz University for health and sciences. Ethical Approval Code: (SP 21R/001/01/R).

Data and materials availability

All data associated with this study are present in the paper.

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