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KNOWLEDGE, ATTITUDE, AND PRACTICE REGARDING ARTIFICIAL INTELLIGENCE IN DENTISTRY AMONG DENTAL STUDENTS, INTERNS, AND DENTISTS IN SAUDI ARABIA.

Samar Abuzinadah[1], Hams Hadi Alshahrani[2], Mohammed H Asiri[2], Rinad Ibrahim Alanazi[3] ,Lama Mohammed Alamoudi[4] , Lujain Sultan Alshareif [2] ,Omar Mohamed Fergani[4],Saad Abdullah Al Silfih[2] ,Rawan Abdullah Alshahrani[2],Hasna B Alshammari[5], Mohammed Waleed Nazer[6],Ghaida Meshari Alotaibi[7], Abdulrahman Alhaddad[8], Khames T. Alzahrani[9].

[1]Assistant Professor and Consultant of Restorative and Digital Dentistry, Restorative Dentistry Department, King Abdul-Aziz University, Faculty of Dentistry, Jeddah, Saudi Arabia.
[2]Dental student, Dental college, King Khalid University, Abha, Saudi Arabia.
[3]Dental student, Aljouf University, Aljouf, Saudi Arabia.
[4]General Dentist, King Abdulaziz University, Jeddah, Saudi Arabia
[5]Dentist, Hail University, Hail, Saudi Arabia.
[6]Dental intern, Ibn Sina national college For Medical Studies, Jeddah, Saudi Arabia.
[7]General Dentist, Ibn Sina national college For Medical Studies, Jeddah, Saudi Arabia.
[8]Assistant Professor and Consultant of Prosthodontics, Oral and Maxillofacial Prosthodontics Department, King Abdul-Aziz University, Faculty of Dentistry, Jeddah, Saudi Arabia
[9]BDS, PGD Endo from Stanford University, Saudi Board of Endodontic SR, King Faisal Specialist Hospital & Research Centre, Riyadh, Saudi Arabia.

Corresponding author: Hams Hadi Al-Shahrani; **Email**: Hamshadi14232@gmail.com

Abstract

Background: Artificial Intelligence (AI) has increasingly became significant in healthcare, including dentistry, and so understanding the perspectives of future dental professionals is crucial for its effective implementation. Past studies indicate a general awareness of AI among dental students and practitioners; however, gaps in knowledge and practical application remain.

Objective: This study aimed to assess knowledge, attitudes, and practices regarding AI in dentistry among dental students, interns, and dentists in Saudi Arabia.

Methods: A cross-sectional study was conducted from July to October 2024 using a self-structured questionnaire. Participants consisted of dental students, interns, and licensed dentists recruited through social media platforms across Saudi Arabia. Statistical analyses were performed to evaluate relationships between demographic factors and AI knowledge and awareness.

Results: A total of 839 participants (mean age: 24.9; 64.5% female) were included. Notably, 90.6% of respondents expressed awareness of AI, yet 46.0% reported having limited to no understanding of its functionality. A significant majority (68.2%) recognized potential AI applications in dentistry, with 85.0% optimistic about its transformative impact. While 78.0% supported the integration of AI into dental education, concerns persisted regarding its potential to replace human expertise, with 44.0% expressing skepticism. Knowledge levels showed that 49.6% demonstrated high knowledge, yet 11.2% had low knowledge of AI applications. Significant associations were found between knowledge and qualification level ($p=0.045$) as well as awareness and place of work ($p<0.0001$).

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Conclusion: This study reveals a high level of awareness of AI among dental professionals in Saudi Arabia, coupled with notable gaps in understanding and practical application. Most participants support the incorporation of AI into dental education, highlighting the need for comprehensive training programs. As AI technology continues to evolve, addressing these gaps will be essential for integrating AI effectively into clinical practices, ensuring readiness for future advancements in dentistry. Our findings underscore the importance of enhancing educational frameworks to better prepare dental professionals for the integration of AI technologies in their practice.

Keywords: Knowledge, attitude, artificial Intelligence in dentistry, dentists, Saudi Arabia

Introduction:

In 1956, the father of Artificial Intelligence John McCarthy introduced the concept of AI and engineered machines and computers with the capability to analyze data according to personal preferences and accomplish predetermined objectives [1]. Artificial intelligence (AI) is becoming an increasingly important aspect of medical education, including medical, dental, and nursing programs. The attitudes and expertise of future healthcare professionals regarding AI are critical for its successful implementation in practice. [2]. Understanding students' perspectives and knowledge of AI is critical in dental education for curriculum development and future clinical tool adoption. Aldowah et al. (2024) conducted a cross-sectional study to evaluate these elements among undergraduate dental students, discovering a broad awareness but a need for greater in-depth understanding and training in AI applications in dentistry [3]. Healthcare personnel's knowledge, attitudes, and practices about artificial intelligence have an important impact on its acceptance in clinical settings. Surbaya et al. (2024) investigated these features among healthcare personnel at private polyclinics in Jeddah, Saudi Arabia, revealing both enthusiasm and learning about the integration of AI in healthcare [4].

The orthodontic community's involvement with AI and machine learning (ML) is crucial to improving patient care. Mengi et al. (2024) used questionnaire study to investigate orthodontic professionals in Northern India's knowledge, attitudes, and use of AI and ML. They found growing interest in the fields, but they also identified limitations in its practical use and understanding. [5].

Assessing dental students' attitudes and perceptions of AI allows educators to modify their teaching practices so that students are more prepared for future technological breakthroughs . Özel and Gümüştaş (2024) discovered that although students are generally positive about AI, they still require additional exposure and instruction to fully understand its potential. [6]. Dental professionals' and students' perspectives on artificial intelligence (AI) are indicative of the field's present situation as well as its likely future direction. In their thorough review of the literature, Dashti et al. (2024) found that different groups had varying degrees of enthusiasm and differing understandings of the subject [7]. The cultural and educational setting can have a considerable impact on the acceptance of AI in dentistry. Jeong et al. (2024) investigated the beliefs and attitudes of dental students and dentists in South Korea, doing a subgroup analysis based on professional seniority and finding generational disparities in AI acceptance and readiness [8]. To identify gaps in education and practice, a thorough assessment of the existing state of awareness and techniques regarding AI in dentistry is necessary. In order to map out these elements, Aldakhil et al. (2024) carried out a scoping review, which offers a general overview of how AI is seen and applied in the dentistry field. [9]. AI is utilized in a multitude of applications within the healthcare sector. It possesses the capability to propel advancements in both medical and dental fields. AI's presence in the dental industry is not yet widespread, the usage of artificial intelligence is improving diagnostic accuracy, treatment planning, and robotic aids for procedures, dental image analysis, caries identification, radiography, and pathology, as well as electronic health record management [10].

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Artificial Intelligence (AI) refers to the mental ability to acquire and retain a diverse range of knowledge and solving skills of the problem by integrates computer and informatic advancements to simulate human intellect to execute tasks that typically demand human intervention [11]. Studies have shown that most students knew about artificial intelligence (AI) and saw its potential benefits in dentistry. Information about AI mainly came from social media. There was general support for including AI in dental education, with female students showing greater awareness and a more favorable view of AI than males [12]Studies have shown that nearly half of the respondents had a basic understanding of artificial intelligence (AI) technologies, while some had no sources of information about AI. The majority agreed that AI would significantly transform the field of dentistry, although a portion did not believe that AI would replace them shortly [13]
Even though there aren't many significant AI uses in the dental field today, the future of AI seems to be bright. There is an irrelevant number of studies related to our topic, especially in Saudi Arabia, so to solve this issue, our research was conducted on artificial intelligence in the dental profession

Objective**:**
The study aimed to evaluate knowledge, attitude, and practices regarding artificial intelligence in dentistry among dental students, interns, and dentists in the Kingdom of Saudi Arabia.
Materials and Methods**:**
Study Design and Setting:
A cross-sectional study was conducted between July 2024 and October 2024, based on a self-structured questionnaire, this study evaluates knowledge, attitude, and practice regarding artificial intelligence in dentistry among dental students, interns, and dentists. Study setting (participants, recruitment, and sampling procedure): To acquire individuals in Saudi Arabia, a sample recruitment technique will rely on social media channels (such as Twitter, Instagram, WhatsApp, Facebook, etc.). Dental communities from all Saudi region made up the study population.
Inclusion and Exclusion Criteria:
Dental students, dental interns, and Saudi Arabian dentists met the study's inclusion requirements. Dental professionals, dental interns, dental students from countries other than Saudi Arabia, and non-dental professionals have been excluded from this study
Sample size:
In order to determine the lowest number of responses required to be a representative sample for the entire population, the following formula was used to calculate the sample size for 384 individuals. Consider the 95% confidence interval's standard deviation (=1.96) and the maximum permissible marginal error (=0.05). Therefore, the calculated minimum sample size required for this study is n= (1.96) ^2X 0.50X 0.50/ (0.50) ^2= 384 participants.
Method for data collection and instrument (*Data collection Technique and Tools)*:
An anonymous, self-administered survey in English served as the survey instrument for this study. It was developed following a review of relevant studies conducted in Saudi Arabia and other countries. The final questionnaire comprised 24 questions divided into 3 main sections. The first section collected demographic information, including age, name, gender, and professional rank. The privacy and confidentiality of the participants' information will be strictly maintained in all published and written data analyses resulting from the study. Consent to participate in this study was implied through the completion of the questionnaire. The second section covered knowledge, with 10 questions assessing participants' knowledge level. Questions about attitudes were addressed in the third section, with 10 questions assessing participants' attitudes. Questions in both the knowledge and attitude sections were obtained from studies conducted by other researchers [3,6,10,13–15]. It is expected that each question

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will take approximately 10 seconds to answer, making the total time for all 24 questions around 5 minutes.

Scoring system:
A total of 24 statements have been used to assess the attitudes and levels of knowledge of the participants. Knowledge accounted for 10 statements; awareness accounted for 10. and demography accounted for 4. The correct answer receives one point, while erroneous or "I don't know" answers receive zero points. Our scoring system was based on Likert scales (Dichotomous, Three-Point, and Quality Scales). Based on the 62-point maximum score, participants will be divided into three groups: 80.0% -100.0%, 60.0% - 79%, and 59.0%, according to Bloom's original cut-offs.
Part I: Knowledge
A total of 10 questions with scores ranging from 0-28 were used to assess participants' knowledge levels. It was determined that those participants with scores between 22-28 had a high knowledge level, those with scores between 17-21 had a moderate knowledge level, and those with scores between 0-16 had a low knowledge level.
Part II: attitude
A total of 10 questions with scores ranging from 0-34 were used to assess participants' awareness. It was determined that those participants with scores between 27-34 had high awareness levels, those with scores between 21-26 had moderate awareness levels, and those with scores between 0-20 had low awareness levels.
Pilot test:
The questionnaire was distributed to 20 individuals, who were asked to fill it out. This was done to test the questionnaire's simplicity and the study's feasibility. Data from the pilot study was excluded from the final data of the study.
Analyzes and entry method:
The "Microsoft Office Excel Software" (2016) Windows program was used to enter data into the computer. Then, the data was loaded into the IBM SPSS Statistics for Windows, Version 20.0 (Armonk, NY: IBM Corp.) statistical analysis application, version 20 of the Statistical Package of Social Science Software (SPSS).

Results:

Table (1) displays various demographic parameters of the participants with a total number of (839). The mean age of the population is 24.9 years, with a standard deviation of 3.8, indicating a relatively young demographic, as evidenced by the substantial distribution of participants under 27 years old, comprising approximately 73% of the sample. Gender representation is striking, with females accounting for 64.5% of participants, which may reflect broader trends in educational and professional settings within the dental field. The overwhelming majority of respondents (91.5%) identify as Saudi nationals, with a notable geographic concentration in the Southern and Western regions, highlighting potential regional disparities in educational and professional opportunities. The qualification levels indicate a diverse mix of dental students (50.7%) and practicing dentists, showcasing the transitional nature of this cohort within the dental profession. Notably, a considerable portion of participants are engaged in academic settings, with half of the respondents working in dental schools.

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Table (1): Sociodemographic characteristics of participants (n=839)

Parameter		***No.***	***Percent (%)***
Age (Mean: 24.9, STD: 3.8)	Less than 23	212	25.3
	23 to 24	229	27.3
	25 to 26	182	21.7
	27 and more	216	25.7
Gender	Female	541	64.5
	Male	298	35.5
Nationality	Non-Saudi	71	8.5
	Saudi	768	91.5
Residential area	Northern region	155	18.5
	Southern region	285	34.0
	Center region	75	8.9
	Eastern region	86	10.3
	Western region	238	28.4
Qualification level	Dental student	425	50.7
	Dental Intern	108	12.9
	General Dentist	306	36.5
Place of work	Dental schools	423	50.4
	Government clinic	146	17.4
	Private clinic	80	9.5
	Other	48	5.7
	I do not work	142	16.9

As shown in figure 1, The data presented indicates a robust favorable sentiment towards the role of Artificial Intelligence (AI) in advancing both dentistry and medicine. Out of a total of 839 respondents, an impressive 75% expressed a strong agreement or agreement with the notion that AI will significantly enhance these fields—specifically, 420 individuals strongly agreed (50%), while 293 agreed (35%). In contrast, a mere 1.5% of respondents (9 individuals) disagreed, and an even smaller fraction (about 0.5%) strongly disagreed. Additionally, 13% remained neutral, suggesting some participants are either unsure of AI's implications or require further information. Overall, the overwhelming majority underscores a high level of optimism regarding AI's potential to revolutionize healthcare practices, improving outcomes and efficiencies in both dentistry and medicine.

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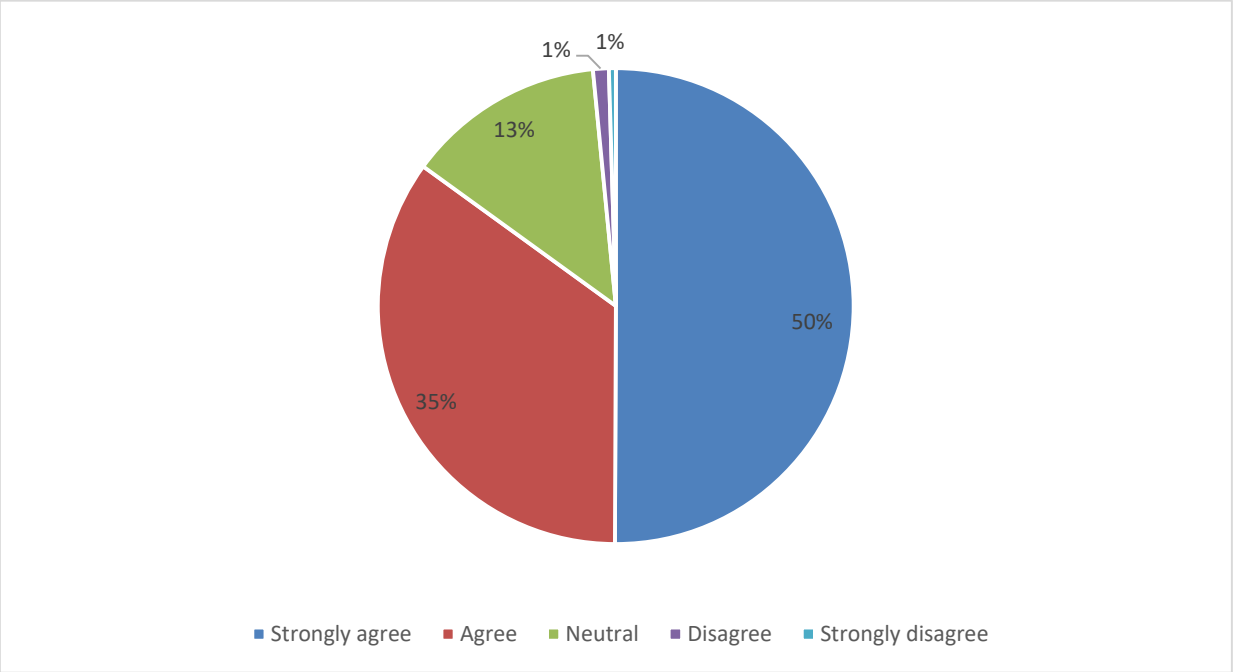
Figure (1): Illustrates if participants think AI will advance the dentistry and medical field.



As illustrated in table (2), The data sheds light on the awareness and understanding of artificial intelligence (AI) among 839 dentists, indicating a significant familiarity with the concept and its potential applications in the dental field. Notably, a commendable 90.6% of respondents acknowledged their awareness of AI; however, a substantial proportion (46.0%) reported either limited or no fundamental understanding of its functioning. Importantly, while 68.2% recognized AI's application in dentistry, nearly one-third remained unaware, highlighting a gap in knowledge that could impede the integration of AI technologies in clinical practice. Most dentists (85.0%) expressed optimism regarding AI's transformative potential, with 50.1% strongly agreeing that it will yield significant advancements in dentistry and medicine. Interesting findings also emerged regarding specific AI applications; for instance, 58.5% believe it can facilitate active data collection from wearables, showcasing a consensus about its advantages. Nevertheless, the perceived inadequacy of training in AI's use, as indicated by 36.6% of respondents.

Table (2): Parameters related to knowledge regarding artificial Intelligence in dentistry among dentists (n=839).

Parameter		***No.***	***Percent (%)***
Do you know what artificial intelligence is?	No	79	9.4
	Yes	760	90.6
Do you have a basic understanding of how Artificial Intelligence works?	Little	242	28.8
	No	143	17.0
	Yes	454	54.1
Are you aware of how Artificial Intelligence is used in Dentistry?	No	267	31.8
	Yes	572	68.2
Do you believe Artificial Intelligence will bring significant advancements to dentistry	Strongly agree	420	50.1
	Agree	293	34.9

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and medicine?	Neutral	113	13.5
	Disagree	9	1.1
	Strongly disagree	4	.5
Can we use Artificial Intelligence be used to diagnose tooth decay through radiographs?	Strongly agree	329	39.2
	Agree	305	36.4
	Neutral	174	20.7
	Disagree	25	3.0
	Strongly disagree	6	.7
AI can be used for:	Active data collection from wearables	169	20.1
	Effective patient monitoring	62	7.4
	Reduce time for record-keeping	92	11.0
	All the above	491	58.5
	None The above	25	3.0
Have you heard of the term AI?	No	95	11.3
	Yes	744	88.7
I have a basic knowledge of the working principles of artificial intelligence.	Strongly agree	246	29.3
	Agree	269	32.1
	Neutral	228	27.2
	Disagree	80	9.5
	Strongly disagree	16	1.9
I am/was trained in the college to use artificial intelligence applications in accordance with their purposes.	Strongly agree	197	23.5
	Agree	169	20.1
	Neutral	166	19.8
	Disagree	175	20.9
	Strongly disagree	132	15.7
Which of the following applications are used in Restorative Dentistry and Prosthodontics? (You can choose more than one) *	Detection of dental caries on radiographs	560	66.7
	Prediction of tooth surface loss with a reasonable degree of accuracy	360	42.9
	Determining which type of restorative material is suitable for a patient	303	36.1
	Prediction of computer color matching of ceramic restorations	382	45.5
	Predicting the change in color of teeth after tooth whitening	265	31.6
	Treatment planning for broken teeth	269	32.1
	I do not know	126	15.0

Results may overlap

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As shown in figure (2), The data indicates a significant inclination towards the acceptance of artificial intelligence (AI) in treatment among respondents. Specifically, 398 participants, representing approximately 45.5%, expressed a preference for AI-based treatment, which suggests a growing trust in technology's role in healthcare. In contrast, 183 individuals, accounting for about 20.7%, indicated a preference against AI interventions, reflecting a notable level of scepticism or concern regarding AI's application in medical contexts. Additionally, 258 respondents, representing 29.3%, maintained a neutral stance, highlighting a considerable segment of the population that remains undecided or ambivalent about this emerging technology.

Figure (2): Illustrates whether participants are willing to using AI in their treatment.

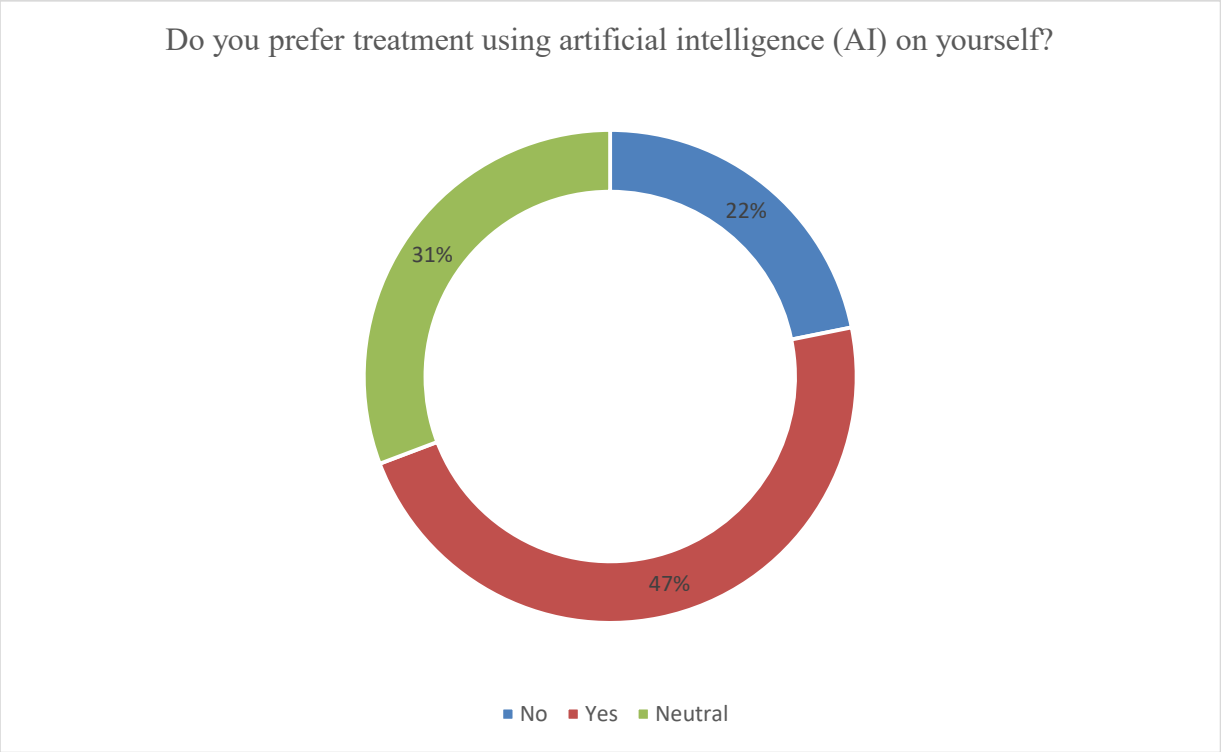

Table (3) reveals a compelling overview of dental professionals' attitudes toward the incorporation of artificial intelligence (AI) within the field of dentistry. A notable majority, comprising 78% of respondents, either strongly agree or agree that AI should be integrated into dental education, highlighting a robust consensus on the necessity of preparing future practitioners for a technologically advanced practice landscape. Conversely, when considering the potential for AI to replace dentists, opinions appear more divided, with approximately 44% expressing skepticism about AI's ability to supplant human expertise. This ambivalence further translates to concerns regarding AI as a burden, where nearly 40% of respondents remained neutral or expressed agreement. However, an overwhelming 84% found AI to be beneficial, reflecting an optimistic outlook on its role in enhancing practice efficiency and patient outcomes.

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Table (3): participants' attitude regarding artificial Intelligence in dentistry among dentists (n=839).

Parameter		***No.***	***Percent (%)***
Do you think AI should be included in the curriculum in dental school as well as specialist training?	Strongly agree	380	45.3
	Agree	274	32.7
	Neutral	142	16.9
	Disagree	35	4.2
	Strongly disagree	8	1.0
Do you believe that AI will replace physicians in the future?	Strongly agree	174	20.7
	Agree	167	19.9
	Neutral	153	18.2
	Disagree	203	24.2
	Strongly disagree	142	16.9
Do you believe AI would be a burden for practitioners?	Strongly agree	163	19.4
	Agree	167	19.9
	Neutral	284	33.8
	Disagree	175	20.9
	Strongly disagree	50	6.0
Do you think the physician's role is important in the application and evaluation of AI in the dental field?	Strongly agree	382	45.5
	Agree	281	33.5
	Neutral	136	16.2
	Disagree	25	3.0
	Strongly disagree	15	1.8
Do you prefer treatment using artificial intelligence (AI) on yourself?	No	183	21.8
	Yes	398	47.4
	Neutral	258	30.8
Does the application of Artificial Intelligence in dentistry and medicine excite you?	Strongly agree	305	36.4
	Agree	259	30.9
	Neutral	216	25.7
	Disagree	38	4.5
	Strongly disagree	21	2.5
How do you find the use of AI in dentistry?	A fantasy	59	7.0
	Exciting	492	58.6
	Neutral	288	34.3
Should Artificial Intelligence be included in undergraduate dental training?	Strongly agree	355	42.3
	Agree	268	31.9
	Neutral	159	19.0
	Disagree	34	4.1
	Strongly disagree	23	2.7
Find the use of AI:	Helpful	705	84.0
	Neutral	97	11.6
	Boring	37	4.4

The data presented in Table 4 illustrates a noteworthy distribution of knowledge levels regarding

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artificial intelligence (AI) in dentistry among a sample of 839 respondents. With 49.6% of individuals reporting a high knowledge level, it is evident that a substantial portion of the sample possesses a solid understanding of AI applications within the dental field. This is complemented by 39.2% exhibiting moderate knowledge, suggesting that most of the respondents are relatively informed about the implications and advancements of AI in dentistry. However, the data reveals a concerning aspect, as 11.2% demonstrate a low knowledge level.

Table (4): Shows knowledge regarding artificial Intelligence in dentistry score results.

	Frequency	**Percent**
High knowledge level	416	49.6
Moderate knowledge	329	39.2
Low knowledge level	94	11.2
Total	839	100.0

The data presented in Table 5 reveals a nuanced landscape of awareness regarding artificial intelligence (AI) within the field of dentistry among respondents. A significant proportion, 50.9%, displays a moderate level of awareness, indicating that while many dental professionals are cognizant of AI's potential applications, their understanding may lack depth or practical integration in clinical practices. Conversely, high awareness is noted in 30.3% of respondents, suggesting a discerning group that likely has engaged with AI technologies or education on the subject, reinforcing their capacity to leverage AI for enhanced patient care and operational efficiency. However, the 18.8% categorized as having low awareness underscores a critical gap that warrants attention.

Table (5): Shows awareness regarding artificial Intelligence in dentistry score results.

	Frequency	**Percent**
High awareness level	254	30.3
Moderate awareness level	427	50.9
Low awareness level	158	18.8
Total	839	100.0

Table (6) shows that knowledge regarding artificial Intelligence among dentists has statistically significant relation to qualification level (P value=0.045). It also shows statistically insignificant relation to nationality, age, gender, residential area, and place of work.

Table (6): Relation between knowledge regarding artificial Intelligence and sociodemographic characteristics.

Parameters		***Knowledge level about AI in dentistry***		***Total (N=839)***	***P value****
		High knowledge	**Moderate or low**		
Nationality	Non-Saudi	42	29	71	0.092
		10.1%	6.9%	8.5%	
	Saudi	374	394	768	

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		89.9%	93.1%	91.5%	
Age	Less than 23	100	112	212	0.333
		24.0%	26.5%	25.3%	
	23 to 24	121	108	229	
		29.1%	25.5%	27.3%	
	25 to 26	96	86	182	
		23.1%	20.3%	21.7%	
	27 and more	99	117	216	
		23.8%	27.7%	25.7%	
Gender	Female	266	275	541	0.746
		63.9%	65.0%	64.5%	
	Male	150	148	298	
		36.1%	35.0%	35.5%	
Residential area	Northern region	76	79	155	0.103
		18.3%	18.7%	18.5%	
	Southern region	124	161	285	
		29.8%	38.1%	34.0%	
	Center region	42	33	75	
		10.1%	7.8%	8.9%	
	Eastern region	47	39	86	
		11.3%	9.2%	10.3%	
	Western region	127	111	238	
		30.5%	26.2%	28.4%	
Qualification level	Dental student	213	212	425	0.045
		51.2%	50.1%	50.7%	
	Dental Intern	64	44	108	
		15.4%	10.4%	12.9%	
	General Dentist	139	167	306	
		33.4%	39.5%	36.5%	
Place of work	Dental schools	222	201	423	0.548
		53.4%	47.5%	50.4%	
	Government clinic	66	80	146	
		15.9%	18.9%	17.4%	
	Private clinic	38	42	80	
		9.1%	9.9%	9.5%	
	I do not work	67	75	142	
		16.1%	17.7%	16.9%	
	Other	23	25	48	
		5.5%	5.9%	5.7%	

P value was considered significant if ≤ 0.05.

Table (7) shows that awareness regarding artificial Intelligence among dentists has statistically significant relation to qualification level (P value=0.008), and place of work (P value=0.0001). It also shows statistically insignificant relation to nationality, age, gender, and residential area.

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Table (7): Relation between awareness regarding artificial Intelligence and sociodemographic characteristics.

Parameters		***Awareness level about AI in dentistry***		***Total (N=839)***	***P value****
		High knowledge	**Moderate or low**		
Nationality	Non-Saudi	26	45	71	0.224
		10.2%	7.7%	8.5%	
	Saudi	228	540	768	
		89.8%	92.3%	91.5%	
Age	Less than 23	58	154	212	0.053
		22.8%	26.3%	25.3%	
	23 to 24	85	144	229	
		33.5%	24.6%	27.3%	
	25 to 26	47	135	182	
		18.5%	23.1%	21.7%	
	27 and more	64	152	216	
		25.2%	26.0%	25.7%	
Gender	Female	169	372	541	0.413
		66.5%	63.6%	64.5%	
	Male	85	213	298	
		33.5%	36.4%	35.5%	
Residential area	Northern region	49	106	155	0.317
		19.3%	18.1%	18.5%	
	Southern region	87	198	285	
		34.3%	33.8%	34.0%	
	Center region	18	57	75	
		7.1%	9.7%	8.9%	
	Eastern region	33	53	86	
		13.0%	9.1%	10.3%	
	Western region	67	171	238	
		26.4%	29.2%	28.4%	
Qualification level	Dental student	133	292	425	0.008
		52.4%	49.9%	50.7%	
	Dental Intern	44	64	108	
		17.3%	10.9%	12.9%	
	General Dentist	77	229	306	
		30.3%	39.1%	36.5%	
Place of work?	Dental schools	153	270	423	0.0001
		60.2%	46.2%	50.4%	
	Government clinic	40	106	146	
		15.7%	18.1%	17.4%	
	Private clinic	27	53	80	

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		10.6%	9.1%	9.5%	
	I do not work	30	112	142	
		11.8%	19.1%	16.9%	
	Other	4	44	48	
		1.6%	7.5%	5.7%	

P value was considered significant if ≤ 0.05.

Discussion:

Dentistry stands out as a specialty that bridges human care and technology, leading to a consistent growth in the use of AI within the dental sector. This growth is driven by heightened demand and the diverse applications AI can offer across various dental specialties [16]. Consequently, we can observe contemporary applications in diagnosing numerous conditions such as vertical root fractures, dental caries, orthodontic cases, and oral and maxillofacial radiology. It is clear that the integration of AI in dentistry is unavoidable, and the field is poised to evolve to embrace this new scientific era [17]. While some clinicians might view the shift toward AI as beneficial, for others it is a priority; nonetheless, this transformation is occurring swiftly, and staying current in this domain has become increasingly essential. The solutions AI provides are being increasingly adopted by practitioners, enhancing their decision-making through its incorporation into diverse healthcare aspects, which include therapeutic protocols, diagnostic recommendations, personalized treatment, patient monitoring, and predicting as well as tracking epidemiological diseases [18]. It is essential to further explore awareness, knowledge, and attitudes towards AI in dentistry, as linking this understanding with the rising implementation of AI in the field remains crucial [19]. The number of studies addressing this topic is on the rise, and understanding the correlation between this knowledge and the application of AI in dentistry can illuminate gaps that, when addressed, can optimize the outcomes of utilizing this technology in dental practice [20]. Thus, we aimed in this study to evaluate knowledge, attitudes, and practices regarding artificial intelligence in dentistry among dental students, interns, and dentists in the Kingdom of Saudi Arabia.

In comparing our findings on the knowledge, attitudes, and practices regarding artificial intelligence (AI) in dentistry with the existing literature, several similarities and disparities emerge. Our study indicates that 90.6% of respondents are aware of AI, significantly higher than the 63.5% awareness reported by Gnanambigai Kalaimani et al. [21]. While a majority in both studies agree on the necessity for AI to be incorporated into dental curricula—over 60% in Kalaimani et al.'s study, and our own finding of 78% highlighting strong support for AI integration in dental education—the perspective on AI replacing dentists shows divergence; only 26.9% in Kalaimani et al.'s study agreed, whereas 44% of our respondents expressed skepticism about AI's potential to replace dentists. The distinction in apprehension underscores a fundamental difference in how dental professionals perceive the role of AI in their future practice. Moreover, the research by Shiva Thulasi et al. [22] and Swed et al. [23] aligns closely with our findings, demonstrating that more than 70% are aware of AI. In contrast, our study reveals that nearly half (46.0%) have limited or no understanding of its functioning, indicating a critical gap between awareness and comprehension. Similarly, Sulthan et al. [24] found that more than 40% of researchers recognized AI's utility in clinical research, paralleling our findings that 68.2% acknowledge the potential applications of AI, while highlighting a shared sentiment that more needs to be done to educate and train professionals in this evolving field. Moreover, Chawla et al. [25] found that 82% of

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periodontists advocate for AI inclusion in postgraduate training, a sentiment echoed in our study by 58.5% believing AI can enhance data collection via wearables. Conversely, Indu et al. [26] reported only 39.6% of oral pathologists possess basic knowledge of AI applications, supporting our observation that while many dental professionals express optimism and recognize AI's potential, significant gaps in understanding and training persist, with 36.6% of our respondents feeling inadequately trained. The perspective of students is also relevant, as Ekici et al. [27] reported that 91.7% believed AI tools could enhance various aspects of dental practice, corroborating our positive outlook on AI capabilities, supported by 85.0% of respondents who see AI as transformative. In line with our findings, 81.2% of dental professionals in Baby et al.'s [28] study support AI integration, reinforcing a widespread recognition of its benefits. The studies by Ding et al. [29] and Hui Jeong et al. [30] further emphasize the broad applications of AI in enhancing clinical efficiency and diagnostic accuracy, paralleling our findings that denote a pronounced familiarity with AI, although tempered by critical gaps in understanding. Notably, Nishi Singh et al. [31] showed that 51.3% reported basic AI knowledge, and 59.6% perceived it as a valuable diagnostic tool, yet they reflected a hesitance to fully integrate AI into practice, mirroring our findings of divided opinions regarding AI's role in replacing dentists. Additionally, Rohan Sachdev et al. [32] highlighted demographic correlations in AI integration preferences, indicative of the complexities surrounding educational and professional backgrounds impacting perceptions of AI alongside our identification of significant relationships between knowledge of AI and qualification levels.

Conclusion:

In conclusion, our study highlights a significant awareness of artificial intelligence (AI) among dental students, interns, and dentists in Saudi Arabia, with 90.6% of respondents familiar with the concept. Despite this awareness, there exists a substantial gap in understanding, with 46.0% lacking a foundational grasp of its functioning. Notably, while 78% advocate for the integration of AI into dental education, approximately 44% express skepticism about AI's potential to replace human expertise, reflecting divided opinions on the future role of AI in dentistry. Our findings indicate both enthusiasm and apprehension, underlining the necessity for enhanced training and educational resources focused on AI applications in dentistry. The study emphasizes the critical need for a revised curriculum that incorporates AI training, empowering future practitioners to utilize these technologies effectively. Addressing these knowledge gaps is essential for the successful integration of AI into clinical practice, ensuring improved patient outcomes and elevating the standard of dental care in the evolving healthcare landscape.

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Ethical approval

An informed consent was obtained from each participant after explaining the study in full and clarifying that participation is voluntary. Data collected were securely saved and used for research purposes only.

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Conflict of interests

The authors declare no conflict of interest.

Informed consent:

Written informed consent was acquired from each individual study participant.

Data and materials availability

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

References:

1. Thulasi MS, Sowjanya B, Sreenivasulu K, Kumar MR. Knowledge Attitude and Practices of Dental Students and Dental Practitioners Towards Artificial Intelligence. Int J Intell Syst Appl Eng. 2022;10(1s):248–53.
2. Amiri H, Peiravi S, rezazadeh shojaee S sara, Rouhparvarzamin M, Nateghi MN, Etemadi MH, et al. Medical, dental, and nursing students' attitudes and knowledge towards artificial intelligence: a systematic review and meta-analysis. BMC Med Educ. 2024 Dec 1;24(1).
3. Aldowah O, Almakrami A, Alghuwaynim Y, Alhutaylah M, Almansour A, Alswedan A, et al. Perceptions and Knowledge of Undergraduate Dental Students about Artificial Intelligence in Dental Schools: A Cross-sectional Study. J Contemp Dent Pract. 2024;25(2):149–55.
4. Surbaya SH, Khan AA, Surbaya SH, Alzahrani SM. Knowledge, Attitude and Practice Toward Artificial Intelligence Among Healthcare Workers in Private Polyclinics in Jeddah, Saudi Arabia. Adv Med Educ Pract. 2024;15:269–80.
5. Mengi A, Singh RP, Mengi N, Kalgotra S, Singh A. A questionnaire study regarding knowledge, attitude and usage of artificial intelligence and machine learning by the orthodontic fraternity of Northern India. J Oral Biol Craniofacial Res. 2024 Sep 1;14(5):500–6.
6. Özel İ, Gümüştaş B. Assessing Student Attitudes and Perceptions Toward the Use of Artificial Intelligence in Dentistry. Essentials Dent [Internet]. 2024 May 17; Available from: https://essentdent.org/en/assessing-student-attitudes-and-perceptions-toward-the-use-of-artificial-intelligence-in-dentistry-1350
7. Dashti M, Londono J, Ghasemi S, Khurshid Z, Khosraviani F, Moghaddasi N, et al. Attitudes, knowledge, and perceptions of dentists and dental students toward artificial intelligence: a systematic review. J Taibah Univ Med Sci. 2024;19(2):327–37.
8. Jeong H, Han SS, Jung HI, Lee W, Jeon KJ. Perceptions and attitudes of dental students and dentists in South Korea toward artificial intelligence: a subgroup analysis based on professional seniority. BMC Med Educ. 2024 Apr;24(1):430.
9. Aldakhil S, Alkhurayji K, Albarrak S, Almihbash A, Aldalan R, Alshehri K, et al. Awareness and Approaches Regarding Artificial Intelligence in Dentistry: A Scoping Review. Cureus. 2024;16(1):e51825–e51825.
10. Kalaimani G, B S, Chockalingam RM, Karthick P. Evaluation of Knowledge, Attitude, and Practice (KAP) of Artificial Intelligence Among Dentists and Dental Students: A Cross-Sectional Online Survey. Cureus. 2023 Sep;15(9):e44656.
11. Karan-Romero M, Salazar-Gamarra RE, Leon-Rios XA. Evaluation of Attitudes and Perceptions in Students about the Use of Artificial Intelligence in Dentistry. Dent J. 2023;11(5):1–13.
12. Asmatahasin M, Pratap KVNR, Padma TM, Siva Kalyan V, Kumar VS. Attitude and Perception

of Dental Students towards Artificial Intelligence. Indian J Basic Appl Med Res [Internet]. 2021 [cited 2024 Jul 8];10:305–14. Available from: www.ijbamr.com
13. Yüzbaşıoğlu E. Attitudes and perceptions of dental students towards artificial intelligence. J Dent Educ. 2021 Jan 1;85(1):60–8.
14. Khanagar S, Alkathiri M, Alhamlan R, Alyami K, Alhejazi M, Alghamdi A. Knowledge, attitudes, and perceptions of dental students towards artificial intelligence in Riyadh, Saudi Arabia. Med Sci. 2021;25(114):1857–1867 WE–Emerging Sources Citation Index (E.
15. Abouzeid HL, Chaturvedi S, Abdelaziz KM, Alzahrani FA, AlQarni AAS, Alqahtani NM. Role of Robotics and Artificial Intelligence in Oral Health and Preventive Dentistry - Knowledge, Perception and Attitude of Dentists. Oral Health Prev Dent [Internet]. 2021 [cited 2024 Jul 8];19(1):353–63. Available from: https://www.researchgate.net/publication/353270917
16. Evaluation of an artificial intelligence system for detecting vertical root fracture on panoramic radiography. Fukuda M, Inamoto K, Shibata N, et al. Oral Radiol. 2020;36:337–343. doi: 10.1007/s11282-019-00409-x. [DOI] [PubMed] [Google Scholar]
17. Application and performance of artificial intelligence technology in detection, diagnosis and prediction of dental caries (DC)-a systematic review. Khanagar SB, Alfouzan K, Awawdeh M, Alkadi L, Albalawi F, Alfadley A. Diagnostics (Basel) 2022;12:1083. doi: 10.3390/diagnostics12051083. [DOI] [PMC free article] [PubMed] [Google Scholar]
18. Scope and performance of artificial intelligence technology in orthodontic diagnosis, treatment planning, and clinical decision-making - a systematic review. Khanagar SB, Al-Ehaideb A, Vishwanathaiah S, et al. J Dent Sci. 2021;16:482–492. doi: 10.1016/j.jds.2020.05.022. [DOI] [PMC free article] [PubMed] [Google Scholar]
19. Artificial intelligence in oral and maxillofacial radiology: what is currently possible? Heo MS, Kim JE, Hwang JJ, Han SS, Kim JS, Yi WJ, Park IW. Dentomaxillofac Radiol. 2021;1:20200375. doi: 10.1259/dmfr.20200375. [DOI] [PMC free article] [PubMed] [Google Scholar]
20. Use of artificial intelligence in dentistry: current clinical trends and research advances. Nguyen TT, Larrivée N, Lee A, Bilaniuk O, Durand R. https://pubmed.ncbi.nlm.nih.gov/34343070/ J Can Dent Assoc. 2021;87:0. [PubMed] [Google Scholar]
21. Kalaimani G, B S, Chockalingam RM, Karthick P. Evaluation of Knowledge, Attitude, and Practice (KAP) of Artificial Intelligence Among Dentists and Dental Students: A Cross-Sectional Online Survey. Cureus. 2023 Sep 4;15(9):e44656. doi: 10.7759/cureus.44656. PMID: 37799215; PMCID: PMC10549783.
22. Knowledge attitude and practices of dental students and dental practitioners towards artificial intelligence. Shiva Thulasi M, Sowjanya B, Sreenivasalu K, Rudra Kumar M. https://ijisae.org/index.php/IJISAE/article/view/2288 Int J Intell Syst Appl. 2022;10:248–253. [Google Scholar]
23. Knowledge, attitude, and practice of artificial intelligence among doctors and medical students in Syria: a cross-sectional online survey. Swed S, Alibrahim H, Elkalagi NK, et al. https://pubmed.ncbi.nlm.nih.gov/36248622/ Front Artif Intell. 2022;5:1011524. doi: 10.3389/frai.2022.1011524. [DOI] [PMC free article] [PubMed] [Google Scholar]
24. Knowledge and attitude of artificial intelligence (AI) technology among clinical researchers in the Kingdom of Saudi Arabia. Sulthan N, Navas S. https://sciencescholar.us/journal/index.php/ijhs/article/view/9513 Int J Health Sci. 2022;6:5937–5947. [Google Scholar]
25. Chawla RL, Gadge NP, Ronad S, Waghmare A, Patil A, Deshmukh G. Knowledge, Attitude

ISSN:1624-1940
http://magellanes.com/

and Perception Regarding Artificial Intelligence in Periodontology: A Questionnaire Study. Cureus. 2023;15(11):e48309.
26. Indu M, Shankar VG, Cherian LM, Krishna R, Paul S, Sathyan P. Assessment of knowledge, attitude, and practice regarding artificial intelligence in histopathology: A cross-sectional study among oral pathologists in India. Saud J Oral Sci. 2022;9(3):157- 62
27. Sharma D, Malik G, Koshy G, Sharma V. Artifical intelligence: need to reboot dental education. Univ J Dent Sci. 2021;7(2):138-42.
28. Ekici O. Artificial Intelligence in Oral and Maxillofacial Surgery: A Survey on Knowledge and Attitudes of Intern Dental Students. J Stomatol Oral Maxillofac Surg. 2023;4653188.
29. Baby D, John L, Pia JC, Sreedevi PV, Pattnaik SJ, Varkey A, et al. Role of robotics and artificial intelligence in oral health education. Knowledge, perception and attitude of dentists in India. J Educ Health Promot. 2023;12:384.
30. Huang C, Wang J, Wang S, Zhang Y. A review of deep learning in dentistry. Neurocomputing. 2023;554:126629.
31. Jeong H, Han SS, Jung HI, Lee W, Jeon KJ. Perceptions and attitudes of dental students and dentists in South Korea toward artificial intelligence: a subgroup analysis based on professional seniority. BMC Med Educ. 2024 Apr 22;24(1):430. doi: 10.1186/s12909-024-05441-y. PMID: 38649951; PMCID: PMC11034023.
32. Singh N, Pandey A, Tikku AP, Verma P, Singh BP. Attitude, perception and barriers of dental professionals towards artificial intelligence. J Oral Biol Craniofac Res. 2023 Sep-Oct;13(5):584-588. doi: 10.1016/j.jobcr.2023.06.006. Epub 2023 Jul 31. PMID: 37576799; PMCID: PMC10415790.
33. Sachdev R., Garg K., Srivastava A. Awareness and education of medical students toward artificial intelligence and radiology: a cross-sectional multicenter. Dent Med Res. 2021;9(2):5. [Google Scholar]