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Artificial Intelligence In Dentistry: Unveiling Perceptions, Practices, And Future Trends Among Dental Professionals- A Cross-Sectional Study

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Background: AI's applications in dentistry are diverse, ranging from the analysis of radiographic images to predictive modeling for treatment outcomes. AI-driven systems can assist in identifying dental pathologies with higher precision, streamline workflows in dental practices, and optimize patient care by personalizing treatment plans This study aims to explore the perceptions, current practices, and anticipated future trends of Artificial Intelligence (AI) among dental professionals. As AI continues to transform various aspects of healthcare, understanding its impact on dentistry is crucial for integrating these technologies effectively into clinical practice.

Methods: A cross-sectional survey was conducted among licensed dental professionals, including general dentists, specialists, and educators. Participants were recruited through professional organizations and academic institutions, and data were collected using a structured online

questionnaire. The survey assessed participants' understanding of AI, its current use in dental practice, and their expectations for its future applications. Descriptive and inferential statistics were used to analyse the quantitative data, while qualitative responses were analyzed thematically.

Results: The findings reveal a diverse range of perceptions toward AI in dentistry, with most participants acknowledging its potential to enhance diagnostic accuracy, treatment planning, and patient management. However, concerns about the reliability, ethical implications, and the need for further training were also prevalent. While a significant number of dental professionals are already incorporating AI tools into their practice, many anticipate broader adoption in the coming years, particularly in areas such as predictive analytics and personalized care.

Conclusion: AI is poised to play a transformative role in dentistry, but its successful integration requires addressing the concerns of dental professionals and providing adequate training. This study highlights the importance of understanding these perceptions and practices to guide the future development and implementation of AI technologies in dental care. By aligning AI advancements with the needs and expectations of dental practitioners, the potential for improving patient outcomes and optimizing clinical workflows can be fully realized.

KEYWORDS: Artificial Intelligence, perceptions, current practices general dentists, specialists, and educators

INTRODUCTION

Artificial Intelligence (AI) is rapidly transforming numerous sectors, including healthcare, by introducing advanced computational techniques that mimic human intelligence. Dentistry, traditionally rooted in manual skills and clinical judgment, is now witnessing the integration of AI technologies. These innovations hold the potential to revolutionize diagnostic procedures, treatment planning, patient management, and even clinical training. AI tools, such as machine learning algorithms and neural networks, have demonstrated significant promise in improving diagnostic accuracy, reducing human error, and enhancing the overall quality of care[1,2]. The integration of Artificial Intelligence (AI) into various sectors of healthcare has ushered in a transformative era, revolutionizing traditional practices and enabling unprecedented advancements in diagnostics, treatment planning, and patient care. Among these sectors, dentistry stands out as a field where AI's potential is beginning to be realized on multiple fronts, ranging from enhanced imaging techniques to predictive analytics and personalized patient management[3,4]. The application of AI in dentistry is not merely a technological upgrade; it represents a paradigm shift that could redefine the roles of dental professionals, the nature of patient interactions, and the overall efficiency of dental care delivery[5,6]. AI technologies, including machine learning, neural networks, and deep learning, are being increasingly utilized to automate and optimize various tasks traditionally performed by dental practitioners[7,8]. For instance, AI algorithms are now capable of analyzing dental radiographs with a level of accuracy comparable to, and sometimes exceeding, that of human experts. This has significant implications for early diagnosis and treatment of dental conditions, potentially reducing the incidence of misdiagnosis and enhancing the precision of interventions. Furthermore, AI's ability to process large datasets rapidly and extract actionable insights is aiding in the development of personalized treatment plans that cater to the unique needs of each patient[9].Despite the promising potential of AI in dentistry, its adoption is not without challenges. The transition to AI-driven practices requires not only significant

investments in technology but also a cultural shift among dental professionals. Concerns regarding the accuracy, reliability, and ethical implications of AI systems are prevalent, and these must be addressed to foster confidence in these emerging tools. Moreover, the role of AI in dental education is becoming increasingly critical, as future dentists must be equipped with the knowledge and skills to effectively integrate AI into their practice[10]. The integration of AI in the curriculum is essential to prepare the next generation of dental professionals for a future where technology and clinical expertise will be inextricably linked. This research aims to explore the perceptions, practices, and future trends of AI in dentistry among dental professionals. By investigating how dental practitioners view AI, how they are currently using it, and what they expect from AI in the future, this study seeks to provide a comprehensive understanding of the current state and potential trajectory of AI in the dental field[11]. The findings from this study will offer valuable insights into the opportunities and barriers associated with AI adoption in dentistry, thereby contributing to the ongoing discourse on the future of dental practice in the digital age[12].

MATERIALS AND METHOD

This study employed a cross-sectional survey design to explore the perceptions, practices, and future trends of Artificial Intelligence (AI) in dentistry among dental professionals. The survey was distributed electronically to a diverse sample of dental practitioners, including general dentists, specialists, and dental educators, across various regions. The study was conducted over a period of three months, ensuring a wide range of responses from participants with varying levels of experience and expertise in AI applications in dentistry. The target population for this study comprised licensed dental professionals, including general dentists, orthodontists, prosthodontists, oral surgeons, periodontists, and dental educators. A sample size of 500 participants was determined to be adequate based on power calculations, ensuring sufficient statistical power to detect differences in perceptions and practices across subgroups. Participants were recruited through professional dental organizations, academic institutions, and social media platforms, ensuring a diverse representation of the dental community. The inclusion criteria include Licensed dental professionals currently practicing or teaching in the field of dentistry and willingness to provide informed consent and complete the online survey. Ethical approval for the study was obtained from the Institutional Review Board (IRB). Informed consent was obtained from all participants prior to their participation in the survey. The consent form outlined the purpose of the study, the voluntary nature of participation, and the confidentiality of the responses. Participants were assured that their identities would remain anonymous, and data would be used solely for research purposes. Comparative analysis was performed to examine differences in technology adoption and perceptions among dental students, postgraduate students, and practitioners. Descriptive statistics was expressed using frequency and percentage distribution. Inferential statistics was done using chi square test to analyze comparison of questionnaire among ug students, Pg students, dental practitioner and academician. To analyse the data SPSS software (version 26.0) is used. Significance level is fixed as 5% ($\alpha = 0.05$). P-value < 0.05 is considered to be statistically significant.

RESULTS

The results showed that undergraduate was found to be 40% of total study participants followed by post-graduate and dental practitioner with 20% each and academician with 20% respectively. The study participants included 22% of practitioner and academician with more than 6 years of experience. While assessing the knowledge and awareness, academician was knowledge about Artificial intelligence, statistically significant difference was seen among maximum questions towards awareness, knowledge and future perspective towards artificial intelligence.

TABLE 1: ASSESSMENT OF DEMOGRAPHIC DETAILS

QUESTIONAIRRE	OPTIONS	FREQUENCY (N)	PERCENTAGE (%)
1. What is your current level of education/professional status?	Undergraduate Student	200	40
	Postgraduate Student	100	20
	Dental Practitioner	100	20
	Academician	100	20
2. How many years of experience do you have in the dental field? (Applicable for dental practitioner and academician)	Less than 1 year	16	8
	1-3 years	68	34
	4-6 years	72	36
	More than 6 years	44	22

TABLE 2: AWARENESS OF PARTICIPANTS TOWARDS AI IN DENTISTRY

Questionairre	Options	Undergraduate students		Post graduate students		Dental practitioner		Academician		P-value
		Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	
How familiar are you with	Not familiar	140	70	67	67	62	62	32	32	0.039*
	Some what	45	22.5	14	14	19	19	16	16	

the concept of Artificial Intelligence (AI) in general	familiar									
	Familiar	15	7.5	19	19	15	15	32	32	
	Very familiar	0	0	0	0	4	4	20	20	
How familiar are you with the applications of AI in dentistry	Not familiar	150	75	69	69	52	52	20	20	0.032*
	Somewhat familiar	45	22.5	12	12	19	19	16	16	
	Familiar	5	2.5	14	14	15	15	31	31	
	Very familiar	0	0	5	5	14	14	33	33	
Which of the following AI applications in dentistry are you aware of	AI-driven diagnostics (e.g., cavity detection)	25	12.5	25	25	25	25	25	25	0.12
	AI in treatment planning (e.g., orthodontic aligners)	25	12.5	20	20	24	24	24	24	
	AI in patient management	32	16	21	21	25	25	25	25	

	(e.g., appointment scheduling)									
	AI in radiographic analysis	45	22.5	20	20	21	21	21	21	
	AI in prosthetic design	0	0	5	5	5	5	5	5	
	Not aware	73	36.5	9	9	25	25	25	25	

TABLE 3: ATTITUDE OF PARTICIPANTS TOWARDS AI IN DENTISTRY

Questionairre	Options	Undergraduate students		Post graduate students		Dental practitioner		Academician		P-value
		Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	
To what extent do you agree with the statement: "AI can improve the accuracy of dental	Strongly disagree	15	7.5	60	60	20	20	20	20	0.045 *
	Disagree	40	20	10	10	15	15	14	14	
	Neutral	20	10	10	10	20	20	14	14	
	Strongly agree	25	12.5	10	10	20	20	15	15	
	Agree	100	50	10	10	25	25	37	37	

diagnose										
How comfortable would you feel using AI-assisted tools in your practice	Very uncomfortable	10	5	50	50	20	20	20	20	0.026*
	uncomfortable	46	23	10	10	15	15	14	14	
	Neutral	10	5	20	20	10	10	15	15	
	comfortable	34	17	10	10	20	20	14	14	
	Very comfortable	100	50	10	10	35	35	37	37	
What are your primary concerns regarding the use of AI in dentistry?	Job displacement	30	15	20	20	10	10	10	10	0.095
	Data privacy	25	12.5	10	10	20	20	10	10	
	Lack of understanding of AI technology	100	50	20	20	20	20	10	10	
	High cost of implementation	23	11.5	10	10	20	20	10	10	
	Ethical concerns	22	11	40	40	30	30	60	60	

TABLE 4: FUTURE TRENDS OF AI

Questionairre	Options	Undergraduate students	Post graduate students	Dental practitioner	Academician	P-value

		Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	
Which AI applications in dentistry do you believe will have the most significant impact in the next 5-10 years	Diagnostic imaging	15	7.5	60	60	20	20	20	20	0.045 *
	Treatment planning	40	20	10	10	15	15	14	14	
	Prosthetics and implants	20	10	10	10	20	20	14	14	
	Orthodontics	25	12.5	10	10	20	20	15	15	
	Endodontics	100	50	10	10	25	25	37	37	
	Others									
What areas of dental education would benefit the most from AI-driven tools	Simulated clinical training	10	5	50	50	20	20	20	20	0.026 *
	Research and data analysis	46	23	10	10	15	15	14	14	
	Diagnostic skill development	10	5	20	20	10	10	15	15	
	Continuing education and skill enhancement	34	17	10	10	20	20	14	14	
	Others	100	50	10	10	35	35	37	37	

How do you foresee AI influencing patient communication and dental care personalization	Minimal influence	30	15	20	20	10	10	10	10	0.095
	Moderate influence	25	12.5	10	10	20	20	10	10	
	Significant influence	100	50	20	20	20	20	10	10	
	Transformative influence	23	11.5	10	10	20	20	10	10	

DISCUSSION

In this rapidly evolving landscape, it is crucial to examine the factors influencing the adoption and utilization of AI in dental practice. The acceptance and integration of AI technologies will likely depend on a range of factors, including the perceived benefits, ease of use, and the extent to which these technologies can be seamlessly incorporated into existing workflows[13,14]. Moreover, understanding the attitudes of dental professionals toward AI, including their concerns and expectations, is essential for guiding the development of AI tools that are not only technologically advanced but also aligned with the needs and preferences of end-users[15]. As AI continues to evolve and its applications in dentistry expand, it is imperative to keep pace with these changes through continuous research and dialogue. Furthermore, AI offers valuable tools for educational purposes, allowing dental students and professionals to engage in simulated environments, improve their diagnostic skills, and stay updated with cutting-edge technologies. Despite these promising advancements, the widespread adoption of AI in dentistry presents challenges. Concerns over ethical considerations, such as patient data privacy and the potential for job displacement among dental professionals, are prevalent. Additionally, the cost of integrating AI technologies and the need for specialized training may pose barriers to acceptance. It is essential to understand how dental professionals perceive these technologies and their readiness to embrace AI-driven innovations in their practice.

This study, therefore, aims to contribute to the growing body of knowledge on AI in dentistry by shedding light on the current perceptions and practices of dental professionals, while also exploring the potential future directions of AI in this field. By doing so, it seeks to provide a roadmap for the integration of AI into dental practice, ensuring that this technology enhances, rather than disrupts, the provision of high-quality dental care[16,17]. AI applications in

dentistry are currently being implemented across various domains. One of the most prominent areas is diagnostic imaging, where AI algorithms are used to analyze dental radiographs, CT scans, and intraoral images. These tools can detect abnormalities with high precision, assisting dentists in early diagnosis and treatment planning[18,19]. In orthodontics, AI is being used to predict treatment outcomes, customize treatment plans, and monitor progress. Similarly, in restorative dentistry, AI-driven software aids in designing prosthetics, ensuring they fit accurately and function optimally. AI is also making strides in patient management systems, automating appointment scheduling, patient follow-ups, and even billing, thereby streamlining the administrative side of dental practice[20]. Despite these advancements, the adoption of AI in daily practice remains limited. This is partly due to the high cost of AI technologies, which can be prohibitive for smaller practices. Additionally, there is a learning curve associated with integrating AI into practice, which can be a barrier for some dental professionals. Artificial intelligence is expected to play an even more significant role in dentistry. One of the most promising areas is personalized dental care, where AI can analyse vast amounts of patient data to create individualized treatment plans that take into account a patient's unique genetic, environmental, and lifestyle factors. This approach could lead to more effective and tailored treatments, improving patient outcomes. Dental professionals' perceptions of AI are generally positive, with recognition of its potential to enhance clinical practice. However, cautious optimism is warranted, as the integration of AI must be approached with a clear understanding of its limitations and ethical implications.

CONCLUSION

As AI technologies continue to evolve, their role in dentistry will likely expand, making it essential for dental professionals to stay informed and adapt to these changes to harness AI's full potential in improving patient care.

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