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Original Article

Perceptions of Dental Professionals Regarding the Role of Artificial Intelligence in Radiographic Assessment and Treatment Planning

Kinza Mubbusher[1], Muhammad Ibrahim Usman Rabb[1], Abdul Raheem Qureshi[1], Shahid Islam[1]

[1] Fatima Jinnah Dental College, Karachi, Pakistan

Correspondence: Qureshinoor11@gmail.com
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ABSTRACT

Background: Artificial intelligence (AI) has rapidly advanced in medicine and dentistry, offering potential to enhance diagnostic accuracy, treatment planning, and data management. Despite global progress, integration of AI into dental practice in low- and middle-income settings remains limited. Awareness and confidence among dental professionals are critical determinants for successful adoption. Objective: To evaluate the knowledge, attitudes, and perceptions of dental professionals in Karachi regarding AI applications in radiographic assessment and treatment planning. Methods: A cross-sectional survey was conducted in February 2024 at three dental institutions in Karachi, Pakistan. A validated, structured questionnaire was distributed to undergraduate students, house officers, postgraduate residents, faculty, and private practitioners. Responses from 314 participants were analyzed using descriptive statistics and Chi-square tests in SPSS version 26.0, with statistical significance defined at $p < 0.05$. Results: Almost all participants (99.0%) reported familiarity with AI, though only 38.8% were extremely aware and 26.0% expressed high confidence in radiographic outputs. Strong endorsement was observed for AI in prognosis (76.0%), data storage (78.0%), forensic applications (72.0%), and education (81.0%). However, 70.0% agreed that radiologists could be replaced by AI, reflecting divided views on workforce implications. Conclusion: Dental professionals in Karachi perceive AI as highly valuable in education and practice but demonstrate limited confidence in its diagnostic reliability. Structured curricular integration and targeted training are essential to bridge the awareness–confidence gap and promote responsible adoption.

Keywords: Artificial intelligence, Attitude, Dentistry, Perception, Radiographic assessment, Training, Treatment planning

INTRODUCTION

Artificial intelligence (AI) has emerged as a cornerstone of the fourth industrial revolution, with applications spanning clinical medicine, biomedical research, and dentistry. Its ability to replicate cognitive tasks such as image interpretation, decision support, and predictive analytics has made it a transformative tool in modern healthcare (1). In dentistry, AI is being applied in areas such as automated caries detection, radiographic interpretation, pathology recognition, implant planning, orthodontic assessments, and digital record management (2–6). Studies have also demonstrated its value in enhancing diagnostic precision, improving workflow efficiency, and supporting robotics in oral surgery (7,8).

Despite these advances, the integration of AI into routine dental practice remains limited. Current evidence highlights promising outcomes in oral radiology, where AI can detect carious lesions, temporomandibular joint disorders, and early oral cancers with high accuracy, supporting timely intervention and better patient outcomes (9–11). However, concerns about data reliability, interpretive errors, and lack of regulatory guidelines hinder widespread adoption (12). Moreover, while AI-based systems are expanding globally, the penetration in low- and middle-income countries has been slow due to resource limitations, insufficient training, and inadequate awareness among clinicians (13).

The acceptance and readiness of dental professionals are central to the successful implementation of AI in clinical practice. Dentists must not only be familiar with AI applications but also develop the ability to critically evaluate algorithmic outputs, communicate AI-assisted findings to patients, and integrate these tools into treatment planning responsibly (14). Prior studies conducted in different countries have shown variable perceptions among dental students, practitioners, and patients, ranging from strong trust in AI-supported diagnostics to skepticism regarding its ability to replace human expertise (15–17). These findings highlight that contextual factors such as education level, clinical exposure, and access to technology may strongly influence professional attitudes.

In Pakistan, where dental education is expanding but formal integration of AI training into curricula remains absent, there is limited research exploring how dental professionals perceive AI's role in radiographic assessment and treatment planning. Understanding their

level of awareness, confidence, and perceived barriers is crucial for designing tailored educational interventions and preparing future practitioners for digital dentistry. Therefore, this study was designed to evaluate the knowledge, attitudes, and perceptions of dental professionals in Karachi—including students, residents, faculty, and private practitioners—regarding the role of AI in radiographic assessment and treatment planning. The research aimed to identify gaps in awareness and confidence, assess training needs, and provide evidence-based recommendations for incorporating AI into dental education and clinical practice.

MATERIALS AND METHODS

This study employed a cross-sectional observational design to assess the perceptions of dental professionals in Karachi regarding the role of artificial intelligence (AI) in radiographic assessment and treatment planning. The rationale for selecting this design was to obtain a snapshot of awareness, attitudes, and confidence levels across diverse categories of dental practitioners within a defined time period, thereby enabling comparisons across educational and professional groups (18).

The survey was conducted in February 2024 at three academic and clinical institutions in Karachi: Fatima Jinnah Dental College and Hospital, Altamash Institute of Dental Medicine, and Ziauddin College of Dentistry. These sites were selected to ensure representation from both private and academic sectors, enhancing the generalizability of the findings within the metropolitan region. Eligible participants included undergraduate dental students, house officers, postgraduate residents, lecturers, senior faculty members, and private dental practitioners currently engaged in clinical or academic practice in Karachi. Individuals not actively practicing dentistry or unwilling to provide informed consent were excluded.

Participants were recruited through institutional circulation lists, faculty networks, and professional groups, and responses were collected using an online Google Forms questionnaire. Informed consent was obtained electronically at the start of the survey, and anonymity was maintained throughout the process. The link remained open until the target sample size was reached. A total of 314 responses were collected, representing the study sample. The sample size was determined based on a priori estimation assuming a prevalence of 50% for AI awareness, a 5% margin of error, and a 95% confidence level, which yielded a minimum requirement of 300 participants; an additional buffer was included to account for potential incomplete responses (19).

The questionnaire was developed through a systematic process. Items were generated following a comprehensive review of published literature on AI applications in dentistry (20–23). Draft questions were reviewed by an expert panel comprising three dental professionals experienced in AI-based research and two methodologists to establish content validity. A pilot study with 10 participants was conducted to assess clarity and feasibility, followed by minor revisions to wording and response categories. Internal consistency reliability was evaluated using Cronbach's alpha, with coefficients ranging between 0.78 and 0.85, indicating satisfactory reliability. Test–retest reliability was further confirmed in a subset of five participants (intraclass correlation coefficient = 0.82). The final questionnaire consisted of three sections: demographic details (age, gender, level of education, and professional role), knowledge of AI applications in dentistry, and attitudes toward AI in radiographic assessment and treatment planning.

Data collection was performed electronically via Google Forms, with responses exported to Microsoft Excel (Microsoft Corp., Redmond, WA, USA) before being imported into IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA) for analysis. Descriptive statistics, including frequencies and percentages, were used to summarize categorical variables. The Chi-square test was applied to evaluate associations between awareness, attitudes, and participant categories. Missing data were handled by listwise deletion. Statistical significance was defined at a p-value < 0.05. Subgroup analyses were conducted to compare perceptions across professional roles and levels of training. Bias was minimized through several strategies.

The anonymous format reduced social desirability bias, and questionnaire items were carefully reviewed to avoid leading or ambiguous wording. Selection bias was limited by recruiting participants from multiple institutions and private practices. Confounding was addressed by stratifying analyses by professional role and level of education. Ethical approval for the study was obtained from the Institutional Ethical and Scientific Review Board of Fatima Jinnah Dental College (approval number: FEB-2024-OPD-01, approved on 16 February 2024). Participation was voluntary, informed consent was secured, and confidentiality of responses was strictly maintained. The study adhered to the principles of the Declaration of Helsinki. To ensure reproducibility, the full questionnaire and dataset are available upon reasonable request.

RESULTS

A total of 314 dental professionals participated in the study, comprising undergraduates, house officers, postgraduate residents, faculty, and private practitioners. Among them, 310 respondents (99.0%) reported familiarity with the term artificial intelligence, though levels of awareness varied considerably (Table 1). Specifically, 122 participants (38.8%) indicated they were extremely aware of AI, while 47 (15.0%) reported moderate awareness. Conversely, 144 respondents (45.8%) were only slightly or somewhat aware, and 3 participants (1.0%) reported no awareness at all ($p < 0.05$). When evaluating confidence in AI outputs for radiographic interpretation, 82 participants (26.0%) reported high confidence, and 138 (44.0%) moderate confidence. In contrast, 31 respondents (10.0%) expressed low confidence, 57 (18.0%) had no personal experience with AI applications, and 6 (2.0%) linked confidence to communication and patient trust ($p < 0.05$).

Perceptions regarding AI's potential applications in dental practice also varied (Table 2). When asked about AI's prognostic capabilities, 239 participants (76.0%) either strongly agreed or agreed that AI can predict disease extent and chance of recovery, whereas only 6 (2.0%) expressed disagreement, and 69 (22.0%) remained neutral ($p < 0.05$). Similarly, 245 respondents (78.0%) endorsed AI's role in storing and retrieving patient data, with only 6 (2.0%) disagreeing, and 63 (20.0%) remaining undecided ($p < 0.05$).

Table 1. Awareness and Confidence in AI among Dental Professionals (n = 314)

Question	Response Categories	n (%)	p-value
Are you aware of the term artificial intelligence?	Extremely aware	122 (38.8)	<0.05
	Moderately aware	47 (15.0)	
	Slightly aware	110 (35.0)	
	Somewhat aware	31 (10.0)	
	Not at all aware	3 (1.0)	
How do you evaluate the quality and accuracy of AI outputs in radiographs?	High confidence	82 (26.0)	<0.05
	Moderate confidence	138 (44.0)	
	Low confidence	31 (10.0)	
	No personal experience	57 (18.0)	
	Communication impacts trust/satisfaction	6 (2.0)	

Table 2. Perceived Applications of AI in Dental Practice (n = 314)

Question	Response Categories	n (%)	p-value
Can AI be used to predict disease extent and chance of recovery?	Strongly agree	82 (26.0)	<0.05
	Agree	157 (50.0)	
	Neutral	69 (22.0)	
	Disagree	5 (1.5)	
	Strongly disagree	1 (0.5)	
Does AI help in storing patient data and retrieval?	Strongly agree	126 (40.0)	<0.05
	Agree	119 (38.0)	
	Neutral	63 (20.0)	
	Disagree	3 (1.0)	
	Strongly disagree	3 (1.0)	
Can AI be used in forensic dentistry?	Strongly agree	101 (32.0)	<0.05
	Agree	126 (40.0)	
	Neutral	63 (20.0)	
	Disagree	16 (5.0)	
	Strongly disagree	8 (3.0)	
Should AI be an essential part of undergraduate/postgraduate training?	Strongly agree	119 (38.0)	<0.05
	Agree	135 (43.0)	
	Neutral	41 (13.0)	
	Disagree	18 (5.7)	
	Strongly disagree	1 (0.3)	

Table 3. Attitudes Toward AI in Radiographic Assessment and Treatment Planning (n = 314)

Question	Response Categories	n (%)	p-value
Can AI assess treatment outcomes and quality control?	Strongly agree	107 (34.0)	<0.05
	Somewhat agree	129 (41.0)	
	Neutral	66 (21.0)	
	Somewhat disagree	3 (1.0)	
	Strongly disagree	9 (3.0)	
Is it important to update AI-related skills and knowledge?	Strongly agree	173 (55.0)	<0.05
	Somewhat agree	88 (28.0)	
	Neutral	44 (14.0)	
	Somewhat disagree	3 (1.0)	
	Strongly disagree	6 (2.0)	
Do you agree that radiologists will be replaced by AI?	Strongly agree	107 (34.0)	<0.05
	Somewhat agree	113 (36.0)	
	Neutral	69 (22.0)	
	Somewhat disagree	9 (3.0)	
	Strongly disagree	16 (5.0)	

In terms of forensic dentistry, 227 participants (72.0%) agreed that AI has potential utility, 63 (20.0%) were neutral, and 24 (8.0%) disagreed ($p < 0.05$). Regarding education, the majority—254 participants (81.0%)—strongly agreed or agreed that AI should be integrated into undergraduate and postgraduate training curricula, while only 19 (6.0%) expressed disagreement ($p < 0.05$).

Attitudinal findings showed divided opinions about AI's role in radiographic assessment and clinical decision-making (Table 3). One-third of respondents (34.0%) strongly agreed and 41.0% somewhat agreed that AI could assist in assessing treatment outcomes and quality control, while 21.0% were neutral and only 12 participants (4.0%) disagreed ($p < 0.05$). The majority of participants—261 (83.0%)—believed it was important to continuously update their knowledge and skills in AI applications, while only 9 (3.0%) disagreed ($p < 0.05$). Interestingly, attitudes toward replacement of radiologists by AI were polarized: 220 respondents (70.0%) strongly or somewhat agreed with the possibility, 69 (22.0%) remained neutral, and 25 (8.0%) disagreed ($p < 0.05$).

Collectively, these findings highlight high levels of awareness and positive perceptions regarding AI's utility in various domains of dentistry but also reveal caution and uncertainty about its reliability and potential to replace human expertise.

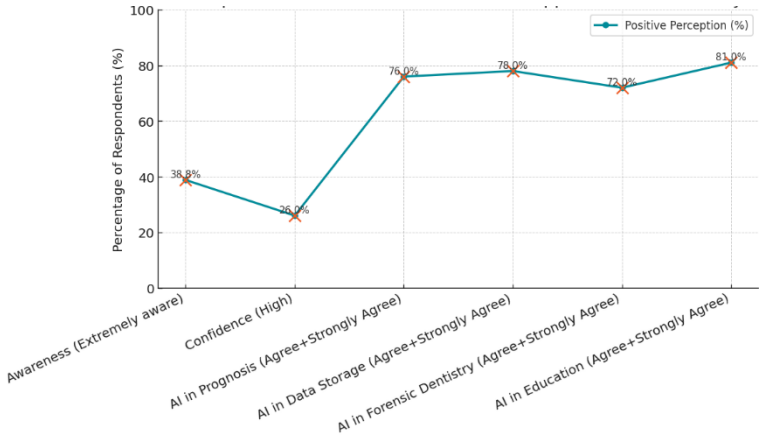

Figure 1 Perceptions of Dental Professionals on AI Applications in Dentistry

The figure illustrates comparative trends in positive perceptions of AI across key domains. Familiarity with AI was moderate, with only 38.8% of participants being extremely aware, while confidence in AI outputs was lower (26.0%). In contrast, support for AI applications in prognosis (76.0%), patient data storage (78.0%), and forensic dentistry (72.0%) was substantially higher. The strongest endorsement was observed for AI integration into dental education, where 81.0% of respondents agreed it should be part of undergraduate and postgraduate training. Collectively, the gradient of responses highlights a gap between awareness/confidence and practical acceptance, emphasizing the need for structured education and training to align professional knowledge with clinical adoption.

DISCUSSION

The principal findings of this cross-sectional survey are that almost all respondents reported familiarity with AI, yet confidence in AI-derived radiographic outputs lagged behind awareness, and views were polarized regarding AI's potential to replace human experts. This awareness–confidence gap echoes broader syntheses in dental informatics: while algorithmic performance in image-based diagnostics is frequently high in research settings, translation to routine clinical decision-making is constrained by data heterogeneity, workflow integration issues, and limited user training (24). In our cohort, strong endorsement of AI for prognosis, data management, and forensic applications coexisted with only modest confidence in accuracy—an asymmetry that suggests perceived utility may be shaped more by expectations of efficiency and information management than by hands-on experience with validated clinical tools (24).

Comparisons with prior surveys indicate both convergence and context-specific differences. Indian oral-radiology and student cohorts have generally shown favorable attitudes toward AI's diagnostic support role but variable trust in automatized interpretation, emphasizing the need for curricular exposure and critical appraisal skills (25,28). Brazilian multicenter data similarly document acceptance of AI's assistive value while underscoring concerns about responsibility, transparency, and user competence (26). In Gulf settings, a sizeable fraction of dentists do not expect wholesale replacement of clinicians by AI, prioritizing human oversight and accountability (27). Among health-professional students in Southeast Asia, most anticipate sustained demand for clinicians even as AI expands, aligning with our respondents' endorsement of integrative training rather than substitution (29). Patient-facing work in radiology further cautions that trust is contingent on communication about how AI is used, error management, and shared responsibility—factors likely to influence clinicians' own confidence and counseling practices (30).

Two implications follow for education and implementation. First, the consistently high support for embedding AI in undergraduate and postgraduate curricula in our sample aligns with calls to move beyond passive exposure toward structured competencies: fundamentals of machine learning, dataset bias and shift, performance metrics (discrimination, calibration), error analysis, and clinical validation pathways (24,28,35). Second, given that respondents endorsed AI most strongly for information handling, programs should integrate "data dentistry" skills—standards for documentation, metadata, governance, and secure retrieval—to ensure that AI-ready datasets are both high quality and ethically stewarded (31,32). These emphases are synergistic: robust records and interoperable pipelines enhance both training data quality and clinician trust in downstream AI tools (31).

Domain-specific applications highlighted by participants warrant tailored guardrails. For radiographic assessment and treatment planning, clinical adoption should prioritize externally validated models with transparent reporting and prospective evaluation in the local case-mix, alongside human-in-the-loop review and clear escalation pathways for discordant outputs (24). In forensic dentistry—another area with strong perceived utility—AI-assisted identification frameworks must be coupled with strict chain-of-custody procedures, audit trails, and method validation to meet evidentiary standards (33). More generally, educational interventions should explicitly address responsibility allocation, documentation of AI involvement in clinical notes, and patient communication practices consistent with emerging norms in radiology (30).

Our findings also add nuance to debates about workforce displacement. The majority expectation that radiologists (or, by extension, oral and maxillofacial radiology experts) could be replaced by AI stands in contrast to reports from Saudi Arabia and surveys of health-professional students in Vietnam, where most respondents foresee augmentation rather than replacement (27,29). This discrepancy may reflect differential exposure to functioning clinical AI systems, media narratives, or local availability of subspecialty radiology services. Curricular modules that demystify model capabilities and limits—anchored in case-based demonstrations of failure modes (e.g., artifacts, domain shift, adversarial inputs)—could recalibrate expectations toward realistic collaboration models (24,28,35).

Strengths of this work include multi-institutional recruitment and an instrument refined through expert review and pilot testing, which likely improved content validity and reliability. Nonetheless, interpretation should consider potential selection bias inherent to online surveys, self-reporting biases, and limited generalizability beyond a single metropolitan region. Future studies should incorporate objective exposure metrics (e.g., documented use of AI-enabled software), longitudinal designs to track attitude change after targeted training, and mixed-methods approaches to elucidate reasoning behind confidence and risk perceptions (24–26,30). Interventional trials of curriculum components—practical labs on dataset curation, performance auditing, and human-AI decision protocols—are especially warranted to test whether educational investments close the observed awareness–confidence gap (31,35).

In summary, dental professionals in this setting endorse AI's practical roles—particularly in prognosis support and data stewardship—yet hesitate to fully trust algorithmic outputs for radiographic decision-making and remain divided on clinician replacement. Aligning education with real-world validation practices, data quality infrastructure, and communication standards offers a feasible pathway from high perceived utility to calibrated, safe, and equitable clinical adoption (24–26,30–32,35).

CONCLUSION

This multi-institutional survey of dental professionals in Karachi demonstrated widespread familiarity with artificial intelligence and strong endorsement of its integration into dental education, data management, and forensic applications. However, confidence in AI-derived radiographic outputs was lower, and attitudes toward its potential to replace clinicians remained divided. These findings underscore an important awareness–confidence gap that highlights the need for structured educational interventions, exposure to validated clinical applications, and transparent training in data stewardship and diagnostic evaluation. Incorporating AI-focused curricula at both undergraduate and postgraduate levels, coupled with professional development opportunities for practicing clinicians, will be critical to bridge knowledge gaps, foster responsible adoption, and ensure that AI enhances rather than disrupts clinical practice. Broader, multi-regional studies with longitudinal and interventional designs are recommended to confirm these trends and to inform evidence-based policies for integrating AI into dentistry.

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