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Artificial Intelligence in Dentistry: Knowledge, Attitudes, and Barriers among Egyptian Dentists and Periodontists — A Cross-Sectional Study

Ghada Gamal Adayil [1], Mihad Ibrahim [2]

[1]*BDS, M.Sc., PhD Lecturer of Periodontology, Faculty of Dentistry, Cairo University, Cairo, Egypt*

[2]*BDS, M.Sc., PhD Candidate in Periodontology, Faculty of Dentistry, Cairo University, Cairo, Egypt*

Abstract

Artificial intelligence (AI) is increasingly integrated into dental diagnostics and treatment planning. Despite its potential, evidence on dentists' knowledge, attitudes, and readiness for adoption remains limited. This study aimed to assess dentists' knowledge, attitudes, and perceived barriers toward AI in dentistry. A cross-sectional survey was conducted among 93 dentists using a structured self-administered questionnaire. Data were analyzed using descriptive statistics and chi-square tests to explore associations between awareness and demographic variables. Overall, 72.0% of participants reported awareness of AI applications, most commonly radiographic diagnosis (47.3%) and digital prosthetics (44.1%). More than half (53.8%) had previously used AI tools. The most frequently reported barriers were high cost (36.0%) and lack of training (50.0%). Confidence in AI was moderate; while 23.7% reported being very confident, 77.4% emphasized the necessity of human validation alongside AI recommendations. Awareness was significantly higher among dentists with prior AI training (85.7% vs. 63.8%, p = 0.022). Dentists demonstrate relatively high awareness of AI but limited confidence and adoption in clinical practice. Integrating AI education into dental curricula and continuing professional development, alongside policy measures to address affordability, may facilitate responsible adoption of AI in dentistry.

Keywords: Artificial Intelligence, Attitude of Health personnel, Dentistry, Periodontics.

Full length article **Corresponding Author*, e-mail: *ghada.adayil@dentistry.cu.edu.eg*

1. Introduction

Artificial intelligence AI is increasingly recognized as one of the most disruptive innovations in modern healthcare[1]. By simulating human intelligence processes through machine learning, neural networks, and deep learning, AI systems have demonstrated strong potential in enhancing diagnostic accuracy, reducing clinician workload, and personalizing patient care [2]. Within dentistry, digital transformation has created fertile ground for AI applications, ranging from diagnostic imaging and treatment planning to prosthetic design and risk prediction [3]. In clinical practice, AI-driven tools already being used to support radiographic interpretation, assisting in the detection of caries, periapical lesions, and periodontal bone loss [4]. Orthodontics has seen rapid integration of AI for cephalometric analysis and treatment simulations [5], while prosthodontics and digital dentistry utilize AI for designing crowns, bridges, and implant-supported restoration [6]. AI is also being explored in periodontics, where risk assessment models to predict susceptibility to periodontal disease ([7], and in oral surgery, where robotic-assisted interventions and image-guided planning are under development [8].

These innovations suggest a future where AI will play a central role in improving accuracy, efficiency, and consistency in dental care [9]. Despite these opportunities, the integration of AI into routine dental practice remains in its infancy ([2]. Several barriers have been consistently reported in the literature, including high implementation costs, lack of adequate training, technical limitations, concerns about data privacy and bias, and medico-legal accountability [10]. Furthermore, dentists often express uncertainty about the reliability of AI predictions and emphasize the need for human oversight in clinical decision-making. While some studies indicate enthusiasm for adopting AI, others highlight skepticism, reflecting a gap between technological potential and real-world acceptance [2-9]. The role of dental education is also crucial in shaping future adoption. Integrating AI-related content into undergraduate and postgraduate curricula has been proposed as a way to enhance familiarity and competence[11]. However, surveys across different countries reveal wide variation in dentists' knowledge and attitudes.

In a review of global evidence[11], Aldakhil et al. noted that although awareness of AI is generally high, actual usage in clinical practice is limited, and misconceptions persist[10]. In the Middle East and North Africa (MENA) region, and specifically in Egypt, evidence remains scarce. While dentistry in Egypt has undergone a rapid digital

transition in recent years, studies systematically assessing dentists' knowledge, attitudes, and barriers regarding AI are lacking [12]. Understanding local perceptions is critical, since successful implementation requires alignment between technological readiness, professional acceptance, and contextual realities such as cost and training availability[11-12]. Therefore, this study was conducted to assess dentists' knowledge of AI applications in dentistry, their attitudes toward its clinical integration, & perceived barriers hindering its adoption. By providing data from a cross-sectional sample of Egyptian dentists, this research aims to inform policymakers, educators, and professional bodies about current readiness of dental community for AI integration.

2. Materials and Methods

All participants provided informed consent before participation. The questionnaire was anonymous, and confidentiality was strictly maintained. The outcome assessor who managed data collection and the statistician performing the analyses were independent of the main researcher, and both were blinded to individual responses to minimize bias.

- ***Study design and setting***

This was a cross-sectional survey conducted at Cairo University between June 2022 and January 2023. The study aimed to assess knowledge, attitudes, and perceived barriers regarding AI in dentistry among practicing dentists.

- ***Participants and eligibility criteria***

The study population included licensed dentists in Egypt, from both general practice and dental specialties. Dentists who were retired or not actively practicing were excluded.

- ***Sample size determination***

The minimum required sample size was calculated based on an expected awareness proportion of 67.16% among dentists, using a 10% margin of error and a 95% confidence interval. According to the formula

$$n = Z2 \times p \times q/d2n = Z2 \times p \times q/d2$$

where $Z =$ 1.96, $p =$ 0.6716, $q =$ 0.3284, and $d =$ 0.1, the estimated sample size was 85. To account for possible nonresponse, a total of 93 participants were included.

- ***Sampling and recruitment***

Participants were recruited through professional networks within Cairo University and affiliated dental institutions. Invitations were distributed electronically, and responses were collected using an anonymized Google Form. Participation was voluntary, and no personal identifiers were recorded.

- ***Data collection instrument***

Data were collected using a structured self-administered questionnaire designed after a review of relevant literature. Questionnaire consisted of four sections:

1. Demographics: specialty, years of clinical experience, and history of formal AI training.
2. Knowledge and awareness: awareness of AI applications, familiarity with AI-driven technologies, and perceived diagnostic capability of AI.
3. Attitudes: confidence in AI, willingness to trust AI-based recommendations, perceptions of AI integration into dental education, and interest in training programs.
4. Barriers: perceived cost, ethical/legal concerns, reliability, and resistance to technological change. Content validity was confirmed by a panel of dental specialists with experience in digital dentistry and research methodology. A pilot test was conducted on a small group of dentists to ensure clarity and face validity. Reliability was assessed using Cronbach's alpha, with internal consistency considered acceptable at $\alpha \geq 0.7$.

- ***Outcome measures***
- Primary outcome: awareness of AI applications in dentistry -yes/no-.
- Secondary outcomes: use of AI tools in practice, levels of confidence in AI applications, attitudes toward curriculum integration, and reported barriers to adoption.

- ***Statistical analysis***

Data were exported from Google Forms into. Descriptive statistics -frequencies and percentages- were used to summarize demographic characteristics, awareness, attitudes, and barriers. Associations between categorical variables, e.g., awareness vs. specialty, years of experience, and prior training were analyzed using chi-square tests. A p-value of <0.05 was considered statistically significant.

3. Results and discussion

3.1. Results

- ***Participant demographics***

A total of 93 dentists participated in the survey. The majority were periodontists (59.1%), followed by general dentists (33.3%) and other specialties (7.5%). Most had 0–5 years of clinical experience (87.1%), while 7.5% had 6–10 years and 5.4% had 11–15 years. Only 37.6% reported receiving formal education or training in AI.

- ***Knowledge and awareness of AI***

Overall, 72.0% of respondents were aware of AI applications in dentistry. The most frequently recognized applications included radiographic diagnosis (47.3%), digital impressions/prosthetic design (44.1%), and treatment planning (39.8%). Less frequently recognized applications were charting/patient records (29.0%), periodontal risk assessment (25.8%), and robotic-assisted surgery (9.7%). Regarding diagnostic capability, 69.9% believed AI can accurately assist in diagnosis, 6.5% disagreed, and 23.7% were unsure. More than half (53.8%) had previously used AI tools, most often CBCT/radiograph analysis (34.4%) and prosthetic/orthodontic workflow systems (23.7%).

- ***Attitudes toward AI***

Confidence levels varied: 2.2% were not confident at all, 8.6% not very confident, 35.5% somewhat confident, and 23.7% very confident. When asked about trust, 77.4% stated that human validation of AI recommendations is always necessary, while 17.2% believed AI could be as accurate as clinicians, and 5.4% were unsure. Most respondents supported integrating AI into dental curricula and expressed interest in further training.

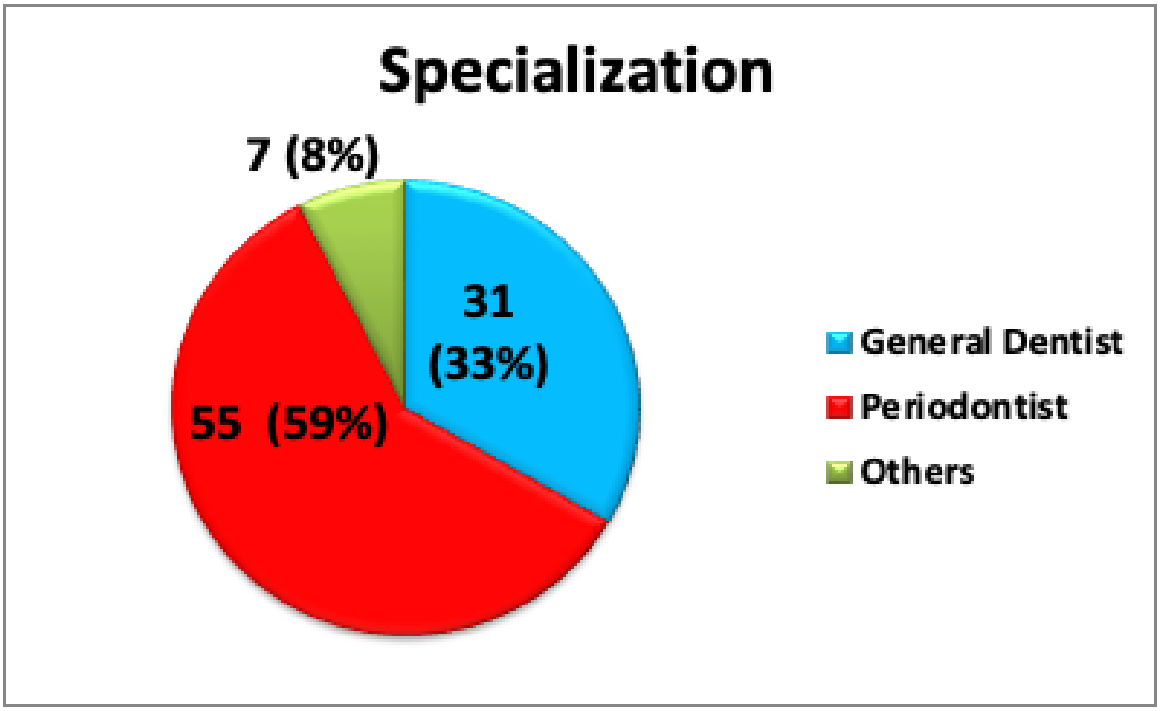


Figure 1. Distribution of dentists by specialization.

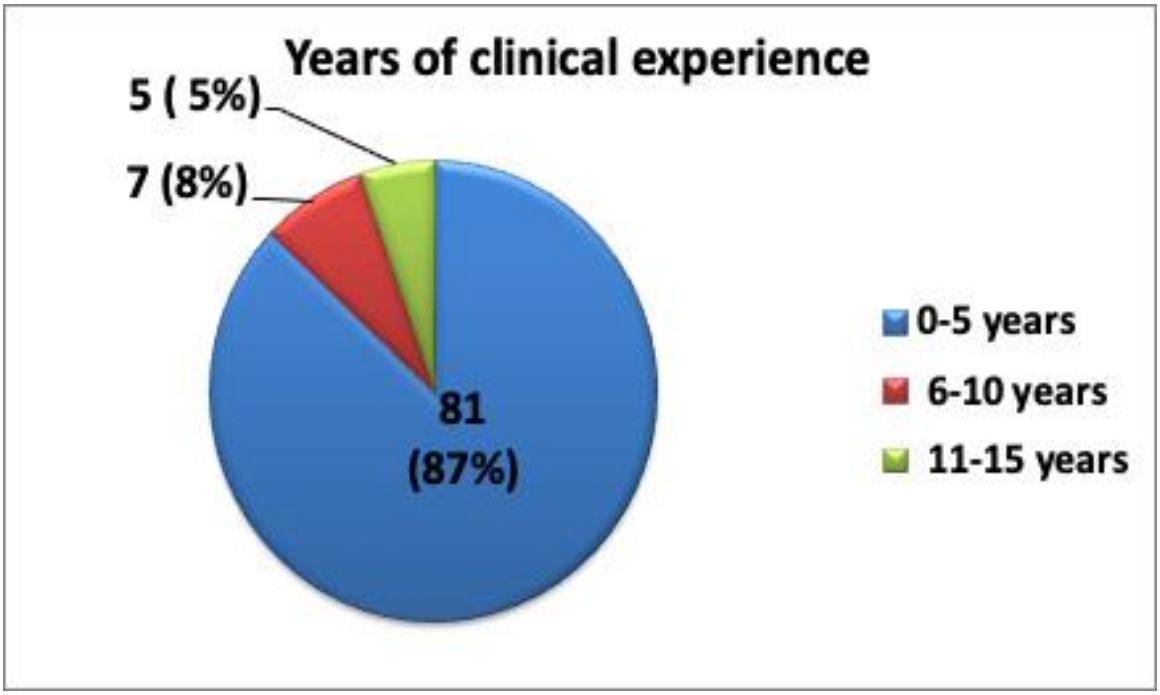


Figure 2. Distribution of dentists by years of clinical experience.

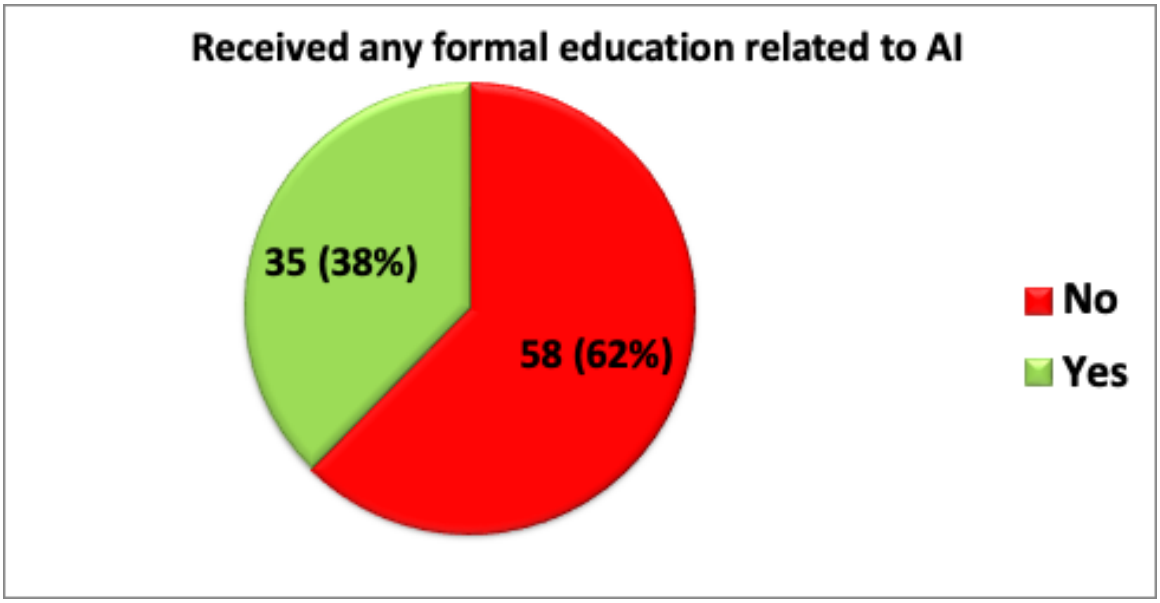


Figure 3. Distribution of dentists by receipt of formal education or training related to AI.

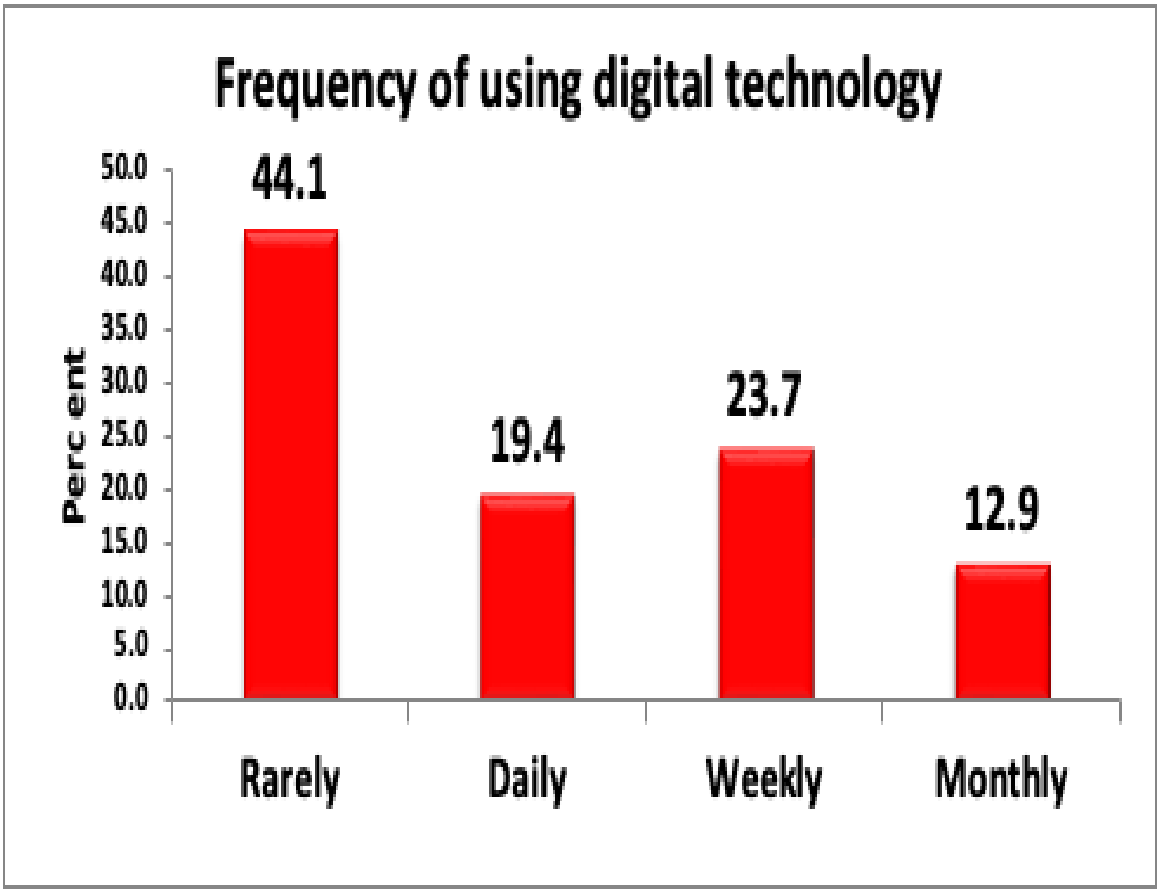


Figure 4. Frequency of using digital technology among dentists.

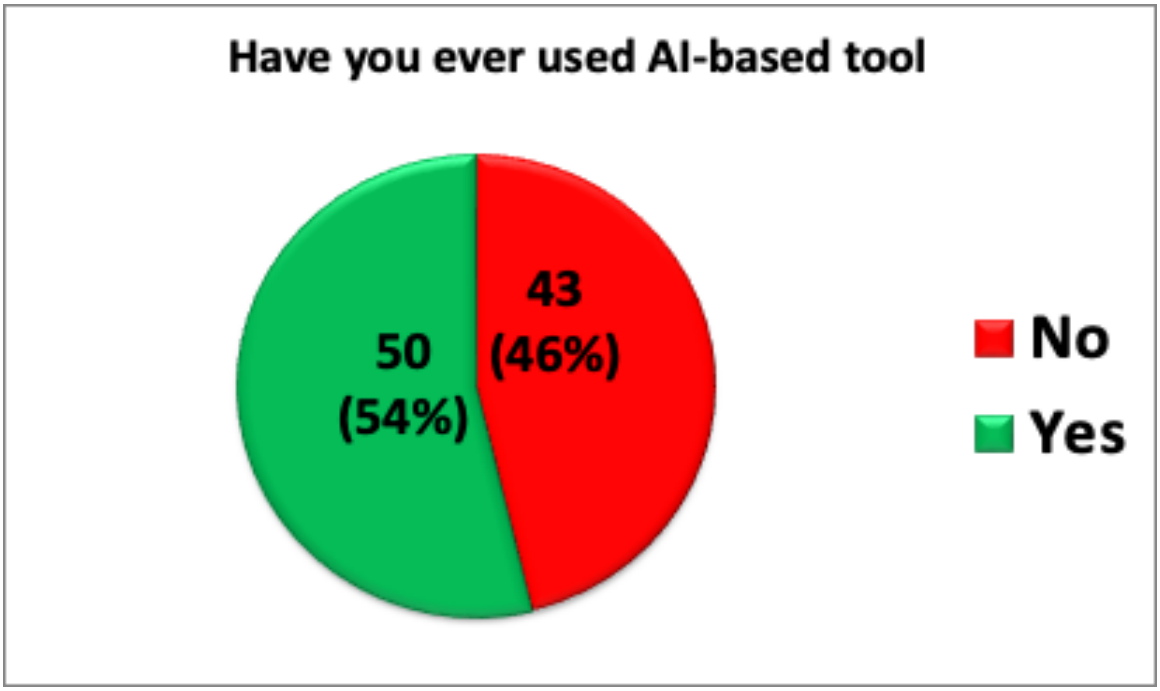
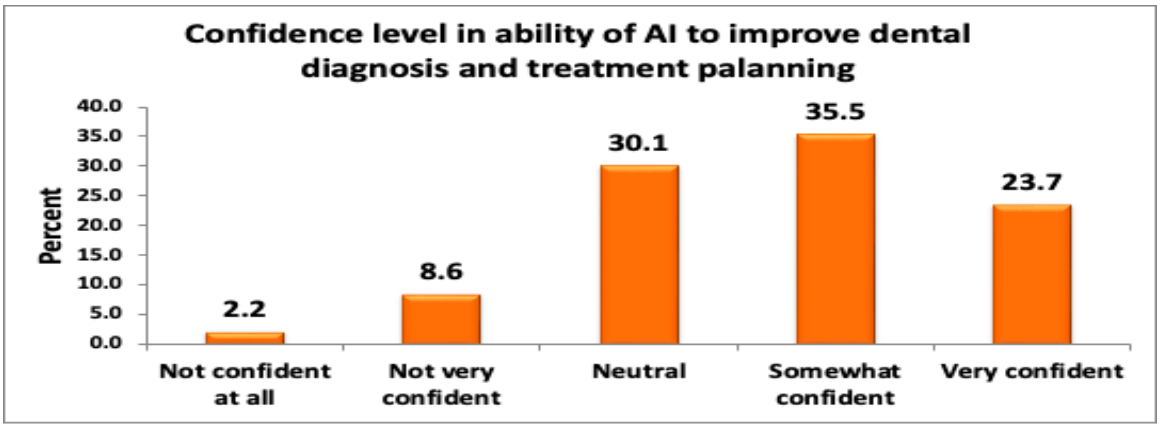


Figure 5. Proportion of dentists who have ever used AI-based tools.



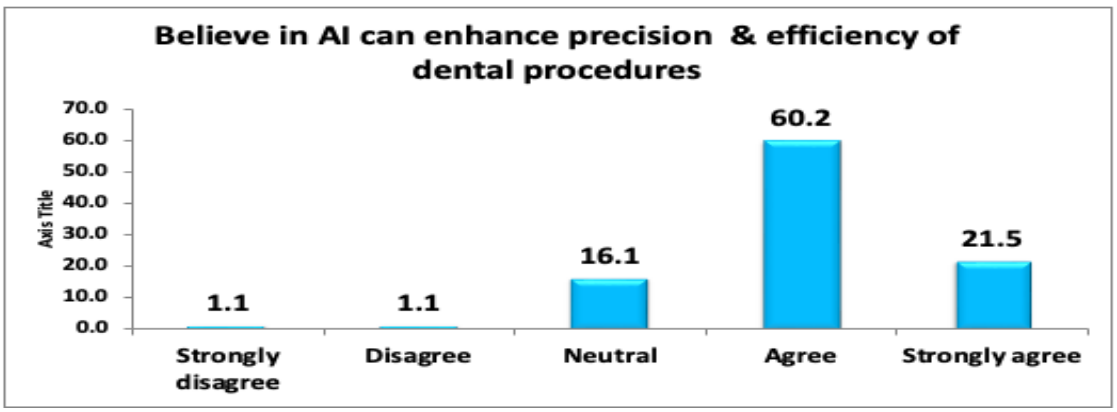


Figure 6. Confidence levels in AI to improve dental diagnosis and treatment planning, and belief in AI's ability to enhance the precision and efficiency of dental procedures.

Table 1: Demographic data

Variable	Category	n	%
Specialization	General dentist	31	33.3
	Periodontist	55	59.1
	Others	7	7.5
Years of experience	0–5 years	81	87.1
	6–10 years	7	7.5
	11–15 years	5	5.4
Formal AI training	Yes	35	37.6
	No	58	62.4
Total		93	100

Table 2: Knowledge and awareness of AI

Item	Response	n	%
Aware of AI applications	Yes	67	72.0
	No	26	28.0
Recognized applications*	Radiographic diagnosis	44	47.3
	Digital impressions/prosthetics	41	44.1
	Treatment planning	37	39.8
	Charting/patient records	27	29.0
	Periodontal risk assessment	24	25.8
	Robotic-assisted surgery	9	9.7
Belief in diagnostic accuracy	Yes	65	69.9
	No	6	6.5
	Not sure	22	23.7
Ever used AI tool	Yes	50	53.8
	No	43	46.2
Tools used*	CBCT/radiograph analysis	32	34.4
	Prosthetic/orthodontic workflow	22	23.7
	Treatment planning software	13	14.0
	Caries/periodontal detection	11	11.8

Table 3: Confidence in AI to improve diagnosis/treatment

Response	n	%
Not confident at all	2	2.2
Not very confident	8	8.6
Neutral	30	30.1
Somewhat confident	33	35.5
Very confident	22	23.7

Table 4: Barriers to AI Adoption

Barrier	% reporting barrier	χ^2	p-value	Significance
High cost of AI tools	36.0	8.34	0.0039	Significant
Ethical/legal concerns	20.9	0.07	0.79	NS
Reliability concerns	26.7	0.02	0.88	NS
Resistance to change	20.9	1.92	0.16	NS

Table 5: Association between years of clinical experience and awareness of AI applications in dentistry

Years of experience	Awareness of AI (No)	Awareness of AI (Yes)	Total	% No	% Yes	χ^2	p-value	Significance
0–5 years	23	58	81	28.4	71.6	0.06	0.807	NS
More than 5 years	3	9	12	25.0	75.0			
Total	26	67	93	28.0	72.0			

Table 6: Association between formal AI training and awareness of AI applications in dentistry

Formal AI training	Awareness of AI (No)	Awareness of AI (Yes)	Total	% No	% Yes	χ^2	p-value	Significance
No	21	37	58	36.2	63.8	5.21	0.022	Significant
Yes	5	30	35	14.3	85.7			
Total	26	67	93	28.0	72.0			

Table 7: Association between specialization and lack of AI training

Specialization	No	Yes	Total	% No	% Yes	χ^2	p-value	Significance
General dentist	10	21	31	32.3	67.7	6.10	0.013	Significant
Periodontist	33	22	55	60.0	40.0			
Total	43	43	86	50.0	50.0			

Table 8: Association between specialization and ethical/legal concerns about AI

Specialization	No (ethical concerns)	Yes (ethical concerns)	Total	% No	% Yes	χ^2	p-value	Significance
General dentist	25	6	31	80.6	19.4	0.07	0.787	NS
Periodontist	43	12	55	78.2	21.8			
Total	68	18	86	79.1	20.9			

Table 9: Association between specialization and resistance to technological change

Specialization	No (resistance)	Yes (resistance)	Total	% No	% Yes	χ^2	p-value	Significance
General dentist	22	9	31	71.0	29.0	1.92	0.166	NS
Periodontist	46	9	55	83.6	16.4			
Total	68	18	86	79.1	20.9			

- ***Barriers to adoption***

The most common barriers were high cost (36.0%), reliability concerns (26.7%), ethical/legal concerns (20.9%), and resistance to technological change (20.9%).
Subgroup analysis showed that:

- General dentists were significantly more likely to report high cost (83.9% vs 52.7%, $\chi^2 = 8.34$, $p < 0.01$).
- Lack of awareness/training was more frequent among general dentists (67.7%) compared to periodontists (40%) ($\chi^2 = 6.10$, $p < 0.05$).
- Ethical/legal concerns, reliability, and resistance to change did not differ significantly by specialty.

- ***Subgroup analyses of awareness***
  - Specialization: Awareness was higher among periodontists (72.7%) compared to general dentists (64.5%), but the difference was not significant ($\chi^2 = 0.63$, $p = 0.426$).
  - Years of experience: Awareness was slightly greater among dentists with >5 years' experience (75.0%) than those with ≤5 years ' experience ([13], not significant ($\chi^2 = 0.06$, $p = 0.807$).
  - Formal training: Dentists with prior AI training were significantly more aware (85.7%) than those without (63.8%) ($\chi^2 = 5.21$, $p = 0.022$).

3.2. Discussion

This cross-sectional survey examined dentists' knowledge, attitudes, and perceived barriers related to artificial intelligence in dentistry. Three main findings emerged. First, the majority of participants were aware of AI applications, particularly in radiographic interpretation and digital prosthetic design. Second, although more than half had experience with AI tools, confidence in their clinical utility remained moderate, and reliance on human validation was strongly emphasized. Third, cost, lack of training, and ethical concerns were identified as the main barriers to adoption, with significant differences between specialties. The overall awareness rate of 72% is consistent with international reports. Aldakhil et al. highlighted similarly high awareness across multiple countries, noting that radiographic analysis was the most commonly recognized application [10]. Likewise, Schwendicke et al. 2020 observed that diagnostic support remains area where AI has achieved the greatest acceptance in dentistry. However, awareness does not necessarily translate into clinical readiness[2]. In the present study, only half of the participants had ever used AI tools, and confidence levels were modest. This aligns with Wong et al [14], who found that although dental professionals expressed optimism about AI's potential, concerns about accuracy, reliability, and accountability hindered wider adoption.

Barriers reported in this study mirror those described in global literature. High cost and insufficient training were the most prominent obstacles. Interestingly, general dentists were more likely to perceive AI tools as costly and reported lower levels of training than specialists. This may reflect differences in exposure, as periodontists and other specialists are often engaged with advanced imaging and digital workflows in academic and hospital settings. Ethical and legal concerns were also cited, echoing the ongoing debate on liability, data privacy, and algorithmic bias in clinical AI applications. The implications of these findings are twofold. First, dental education should play a central role in preparing practitioners for AI integration. Curricular modules, continuing professional development (CPD) courses, and hands-on workshops can improve both knowledge and confidence. Second, policy-level interventions are needed to address cost barriers, including partnerships with technology providers and subsidies for academic institutions. Without

these measures, the gap between technological advances and clinical application will persist.

This study has several strengths. It provides one of the first assessments of AI awareness and attitudes among dentists in Egypt, addressing a gap in regional evidence. Use of anonymized online data collection ensured candid responses, and blinding of outcome assessor and statistician minimized bias. Nevertheless, limitations must be acknowledged. The sample was modest in size and largely drawn from Cairo University and affiliated institutions, which may limit generalizability. Responses were self-reported and thus subject to social desirability and recall bias. Finally, the cross-sectional design captures perceptions at a single point in time, and longitudinal studies are needed to assess how awareness and adoption evolve as AI becomes more widespread. Future research should extend to larger, nationally representative samples and explore differences across specialties, practice settings, and age groups. Qualitative studies may also provide deeper insights into practitioners' concerns and expectations. Evaluations of educational interventions and cost-effectiveness analyses will further guide policy and curriculum development.

4. Conclusion

This study demonstrates that while dentists in Egypt show relatively high awareness of artificial intelligence and recognize its potential applications in clinical practice, confidence in AI systems remains moderate, and actual use is limited. The findings highlight that high cost, lack of training, and ethical concerns continue to hinder wider adoption. Importantly, dentists overwhelmingly emphasize necessity of human validation alongside AI tools, underscoring the view that AI should serve as an adjunct rather than a replacement for professional judgment. To bridge the gap between awareness and adoption, integrating AI education into dental curricula and continuing professional development programs is essential. Policy measures that address affordability and standardization will further support responsible implementation. By aligning technological readiness with professional preparedness, AI has potential to enhance diagnostic accuracy, improve efficiency, and transform dental practice in Egypt and beyond.

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