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Original article

Assessment of Knowledge, Attitudes, Practices, and Barriers Toward AI in Dental Prosthesis Design in Benghazi, Libya

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Abstract
Artificial intelligence (AI) is increasingly influencing dental practice, particularly in prosthodontics, by enhancing precision, efficiency, and patient-specific outcomes. This study aimed to evaluate the knowledge, attitudes, practices, and perceived barriers related to AI-assisted prosthesis design among dentists and dental technicians in Benghazi, Libya. A cross-sectional online survey was conducted with 204 participants, including 189 dentists and 15 dental technicians, using a structured questionnaire covering knowledge, attitudes, practices, and perceived barriers, with responses recorded on a five-point Likert scale. Data analysis explored differences based on professional experience and role. Results showed moderate knowledge (mean ± SD: 3.48 ± 0.61) and generally positive attitudes (3.90 ± 0.71), but current practical use remained limited (practices 3.69 ± 0.65). The main barriers were lack of training (3.82 ± 0.90) and high cost (3.66 ± 0.90), while concern about AI replacing human roles was low (2.81 ± 1.14). Participants with more than 10 years of experience had significantly more favorable attitudes ($p = 0.016$) and perceived fewer barriers ($p = 0.036$). These findings indicate that dental professionals are receptive to AI in prosthesis design, but structured training, practical workshops, and improved accessibility of AI tools are essential to promote effective integration into clinical and laboratory workflows.
Keywords. Artificial Intelligence, Dentistry, Prosthodontics, Dental Prosthesis, Attitudes.

Introduction

Artificial intelligence (AI) is transforming healthcare by enabling advanced data analysis, pattern recognition, and clinical decision support through machine learning (ML) and deep learning (DL) technologies [1,2]. In dentistry, AI has been applied to improve diagnostic accuracy, interpret radiographs, optimize treatment planning, and integrate into digital workflows [2,3].

Prosthodontics, the discipline focused on restoring and replacing missing teeth, demands precision in both function and aesthetics. Designing dental prostheses involves evaluating occlusion, morphology, implant positioning, and biomechanics. While CAD/CAM systems improve efficiency and standardization, AI can further enhance prosthetic design by reducing operator variability and providing patient-specific solutions [3–5]. Recent studies report AI applications in prosthodontics, including automated implant identification, margin detection, occlusal analysis, and digital prosthesis planning [6–8]. Deep learning models, such as convolutional neural networks, have shown high accuracy in classifying implants and analyzing radiographs [7]. AI-driven prosthetic software can use large datasets to predict optimal morphology and streamline workflows [6,8].

Despite technological advances, successful AI adoption relies on the knowledge, confidence, and willingness of dental professionals. Dentists and dental technicians play a key role, and their perceptions strongly influence implementation in clinical and laboratory settings [9–14]. Previous studies report generally positive attitudes toward AI, yet barriers such as limited training, high cost, ethical concerns, and fear of professional replacement persist [1,5,9,10]. Importantly, research examining both dentists' and dental technicians' perspectives on AI-assisted prosthetic design in Libya is lacking [15,16]. Understanding these views is critical to identify obstacles, inform educational programs, and support responsible AI integration in prosthodontics. The present study, therefore, assesses knowledge, attitudes, practices, and perceived barriers toward AI in dental prosthesis design among dentists and dental technicians in Benghazi, Libya, while exploring factors influencing acceptance.

Methods

Study Design and Participants

A cross-sectional online survey was conducted in Libya between November 2025 and January 2026 to assess knowledge, attitudes, practices, and perceived barriers regarding AI in dental prosthesis design. Participants included undergraduate dental students, general practitioners, specialists, and dental technicians from governmental, private, and mixed practice settings.

Participation in the survey was voluntary and anonymous, with no identifying information collected. Completion of the survey constituted informed consent, and all data were handled confidentially for research purposes.

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Data Collection
The questionnaire was distributed via email and professional social media groups. Two reminder messages were sent to increase response rates. The study followed the CHERRIES checklist for web-based surveys [13].

Questionnaire Development
The survey was adapted from previously validated instruments [15,16] and included four domains: knowledge (8 items), attitudes (4 items), practices (6 items), and perceived barriers (5 items). Sociodemographic data collected included profession, level, years of experience, workplace, and gender. Responses were recorded on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree), with an "I do not know" option to reduce bias.
Face and content validity were confirmed by experts in prosthodontics and dental informatics. A pilot study with 20 participants ensured clarity and readability. Internal consistency (Cronbach's alpha) ranged from 0.78 to 0.92 across domains [12].

Statistical Analysis
Data were analyzed using IBM SPSS Statistics version 23. Continuous variables were presented as mean ± SD, and categorical variables as frequencies and percentages. Normality was tested with the Shapiro–Wilk test. Parametric tests (t-test, ANOVA) were applied for normally distributed data; non-parametric tests (Mann–Whitney U, Kruskal–Wallis) were used for non-normal distributions. Associations between categorical variables were analyzed with chi-square or Fisher's exact tests. Significance was set at $p < 0.05$.

Results
Participant Characteristics
A total of 204 participants completed the survey, including 189 dentists (92.6%) and 15 dental technicians (7.4%). Among dentists, 36.3% were specialists, 25.0% general dental practitioners, and 31.4% undergraduate students. Most participants were female (75.0%), and approximately half (50.5%) had less than five years of professional experience. Participants were distributed across governmental (32.8%), private (35.3%), and mixed practice settings (31.9%) (Table 1).

Table 1. Demographic characteristics of participants

Characteristics	No.	(%)
Profession		
Dentist	189	92.6%
Dental Technician	15	7.4%
If Dentist, level:		
Specialist	74	36.3%
General Dental Practitioner (GDP)	51	25.0%
Undergraduate dental student	64	31.4%
Years of experience:		
Less than 5 years	103	50.5%
5–10 years	24	11.8%
More than 10 years	77	37.7%
Workplace		
Governmental	67	32.8%
Private	72	35.3%
Both	65	31.9%
Gender		
Male	51	25.0%
Female	153	75.0%

Knowledge of AI in Dentistry
Participants demonstrated moderate knowledge of AI in dentistry (overall mean ± SD: 3.48 ± 0.61). Awareness was higher for clinical decision support and general prosthodontic applications, while familiarity with specific AI tools for prosthetic design was limited (Table 2).

Attitudes and Practices Toward AI
Participants expressed positive attitudes toward AI (mean ± SD: 3.90 ± 0.71) and willingness to adopt it, though current use remained limited (practices mean ± SD: 3.69 ± 0.65) (Table 3).

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Table 2. Knowledge of AI in dentistry

Statement	Mean ± SD	Level of Agreement
I have basic knowledge about how AI works	3.64 ± 1.31	Agree
I am aware of the applications of AI in dentistry	3.60 ± 0.95	Agree
I know how AI can be used in clinical practice	3.49 ± 0.98	Agree
AI tools are available where I work/study	2.80 ± 1.22	Neutral
AI can support (but not replace) clinical decision-making	4.06 ± 0.98	Agree
I am aware of AI applications in prosthetic design	2.80 ± 1.30	Neutral
AI can improve the accuracy and fit of dental prostheses	3.64 ± 0.88	Agree
AI-based prosthetic design can reduce fabrication time	3.94 ± 0.86	Agree
General Mean ± SD	3.48 ± 0.61	Agree

Table 3. Attitudes and practices toward AI in dentistry

Domain	Statement	Mean ± SD	Level of Agreement
Attitude	AI can improve dental diagnosis and treatment outcomes	3.92 ± 1.04	Agree
Attitude	AI will be important in future dental practice	4.06 ± 1.00	Agree
Attitude	AI should be included in dental education	4.02 ± 0.86	Agree
Attitude	Final clinical decisions should remain the dentist's responsibility	4.16 ± 0.99	Agree
General Mean ± SD		3.90 ± 0.71	Agree
Practice	I currently use AI for imaging, diagnosis, or treatment planning	2.99 ± 1.27	Neutral
Practice	I am comfortable using AI systems in professional work	3.71 ± 0.94	Agree
Practice	I would recommend using AI applications to colleagues	3.82 ± 0.86	Agree
Practice	I am willing to participate in AI training/workshops	3.97 ± 0.91	Agree
Practice	Clear guidelines and regulations are needed	4.00 ± 0.92	Agree
Practice	Adequate technical support would increase my willingness	3.87 ± 0.85	Agree
General Mean ± SD		3.69 ± 0.65	Agree

Perceived Barriers

Main barriers were a lack of training and high costs. Concern about AI replacing human roles was relatively low (mean ± SD: 2.81 ± 1.14), indicating neutral perception. (Table 4).

Table 4. Perceived barriers to AI adoption

Statement	Mean ± SD	Level of Agreement
I am concerned AI may replace human roles	2.81 ± 1.14	Neutral
Lack of training is a barrier	3.82 ± 0.90	Agree
The cost of AI systems is a significant barrier	3.66 ± 0.90	Agree
I trust AI-generated prosthetic designs as much as traditional methods	3.44 ± 0.93	Agree
I feel ready to integrate AI into daily practice	3.65 ± 0.89	Agree
General Mean ± SD	3.47 ± 0.55	Agree

Comparisons by Profession, Level, and Experience

No statistically significant differences were observed in knowledge, attitudes, practices, or perceived barriers between dentists and dental technicians or among dentist subgroups ($p > 0.05$). Years of professional experience were significantly associated with attitudes ($p = 0.016$) and perceived barriers ($p = 0.036$), with more experienced participants demonstrating more favorable attitudes and slightly lower perceived barriers (Table 5).

Table 5. Mean scores by years of experience

Dimension	<5 years	5–10 years	>10 years	p-value
Knowledge	3.44 ± 0.59	3.35 ± 0.51	3.57 ± 0.65	0.197
Practices	3.63 ± 0.67	3.64 ± 0.81	3.78 ± 0.55	0.292
Attitudes	3.80 ± 0.78	3.76 ± 0.73	4.08 ± 0.56	0.016
Barriers	3.38 ± 0.57	3.62 ± 0.54	3.55 ± 0.50	0.036

Discussion

This study examined the knowledge, attitudes, practices, and perceived barriers regarding AI-assisted dental prosthesis design among dentists and dental technicians in Benghazi, Libya. Overall, participants showed moderate understanding of AI and generally positive attitudes, though practical implementation remained

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limited. The main obstacles identified were a lack of training and high costs, whereas concerns about AI replacing human roles were relatively low, indicating that AI is perceived primarily as a supportive tool rather than a substitute for professional expertise. Interestingly, participants with more than ten years of experience reported significantly more favorable attitudes and fewer perceived barriers, suggesting that clinical experience may enhance receptivity to AI technologies.

The moderate knowledge levels observed in this study (mean ± SD: 3.48 ± 0.61) are consistent with previous reports indicating that dental professionals are aware of AI applications in principle but may lack familiarity with specific prosthetic design tools [1,2,8]. These findings highlight the importance of targeted educational interventions to bridge the gap between conceptual understanding and practical competence.

Participants exhibited positive attitudes toward AI (mean ± SD: 3.90 ± 0.71), which aligns with prior research in dentistry and broader healthcare settings demonstrating optimism about AI's potential despite limited hands-on experience [9,10]. Notably, participants emphasized that final clinical decisions should remain under the dentist's responsibility (mean ± SD: 4.16 ± 0.99), reflecting the importance of professional autonomy and corroborating observations from other studies [11]. This suggests that AI is viewed as a complementary decision-support system rather than an autonomous clinical agent.

Despite favorable perceptions, actual AI usage remained moderate (mean ± SD: 3.69 ± 0.65), indicating that positive attitudes do not necessarily translate into regular clinical practice. Similar trends were reported in studies conducted in Libya and other regions, where dentists recognized AI's potential but faced practical barriers to implementation [15,16]. These findings emphasize the need for structured training programs, institutional support, and improved accessibility of AI technologies to translate knowledge and attitudes into practice.

Among the barriers, lack of training (mean ± SD: 3.82 ± 0.90) and high cost (mean ± SD: 3.66 ± 0.90) were the most prominent, reflecting global challenges in AI adoption within dentistry [8,9]. Concerns about professional replacement were comparatively minor, supporting the perception of AI as an enhancement tool rather than a threat to professional roles.

The influence of professional experience on attitudes and perceived barriers suggests that clinicians with greater exposure to practice are more confident in integrating new technologies into existing workflows. This observation is in line with previous studies that reported higher acceptance of digital tools among experienced dental practitioners [1,3]. Nevertheless, the study has some limitations. The small sample of dental technicians (n = 15) may restrict subgroup comparisons, and the cross-sectional design does not allow for causal inference. Self-reported responses may also be subject to social desirability bias. Future research should include larger, more balanced samples and consider longitudinal approaches to assess changes in AI adoption over time and its impact on prosthodontic outcomes. Overall, the findings indicate that dental professionals in Benghazi are open to incorporating AI in prosthetic design. However, successful implementation requires structured educational programs, hands-on workshops, accessible AI systems, and clear guidelines to ensure safe, ethical, and effective integration into clinical and laboratory practice.

Conclusion and Recommendations

Dental professionals in Benghazi, Libya, demonstrate moderate knowledge and generally positive attitudes toward AI in prosthesis design, while practical use remains limited. Main barriers were a lack of training and high costs; concern about professional replacement was low. Professional experience was associated with more favorable attitudes and lower perceived barriers. Structured educational programs, practical workshops, and improved accessibility of AI technologies are recommended. Further large-scale and longitudinal studies are needed to evaluate long-term clinical impact.

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Conflicts of interest

There are no conflicts of interest.

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