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Utilization of Artificial Intelligence Tools in Dentistry and Its Perception Among Dental Students: A Cross-Sectional Study

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KEYWORDS

Artificial intelligence, Dental education, Dental students, Generative AI, Clinical decision support

ABSTRACT:

Introduction: Artificial intelligence (AI) refers to computational systems capable of performing tasks that traditionally require human intelligence, such as natural language processing, pattern recognition, and decision support. In recent years, AI tools—particularly large language models (LLMs) such as ChatGPT, Google Gemini, and Microsoft Copilot—have increasingly influenced educational processes and clinical workflows across healthcare professions, including dentistry. Therefore, this study aims to assess the utilization of diverse AI tools available to dental students and to evaluate their awareness, perceptions, and attitudes toward incorporating these technologies into dental education and future clinical practice.

Materials & Methods: A cross-sectional questionnaire-based study was conducted among 408 dental students (336 BDS and 72 MDS) in a private dental college. A validated, self-administered questionnaire assessed sociodemographic details, awareness, utilization, and perceptions of AI tools. The questionnaire demonstrated good content validity (CVI = 0.89) and internal consistency (Cronbach's alpha = 0.82). Descriptive and inferential statistics were applied, and $p < 0.05$ was considered statistically significant.

Results: Overall awareness of AI tools was high, with ChatGPT being the most recognized platform (89.9% BDS; 97.2% MDS). MDS students demonstrated significantly higher awareness of most AI tools compared to BDS students ($p < 0.05$). AI utilization was predominantly academic, including learning, examination preparation, literature search, and research writing. Clinical decision-support usage was comparatively low but significantly higher among MDS students (22.2%) than BDS students (7.7%) ($p < 0.001$). Perceptions toward AI were generally positive, with a majority agreeing that AI enhances learning efficiency (75.0% BDS; 88.9% MDS). Ethical concerns were reported by both groups, more frequently among BDS students (66.7%). Composite scores for awareness, utilization, and perception were significantly higher among MDS students ($p < 0.001$).

Conclusion: Dental students exhibited high awareness and favourable perceptions of AI tools, with utilization primarily focused on academic and research purposes. Postgraduate students demonstrated greater engagement and more positive attitudes than undergraduates. Structured incorporation of AI literacy, ethical guidance, and supervised clinical integration into dental curricula is recommended to ensure responsible and effective adoption of AI technologies.

INTRODUCTION

Artificial intelligence (AI) refers to computational systems capable of performing tasks that traditionally require human intelligence, such as natural language processing, pattern recognition, and decision support. In recent years, AI tools—particularly large language models (LLMs) such as ChatGPT, Google Gemini, and Microsoft Copilot —have increasingly influenced educational processes and clinical workflows across healthcare professions, including dentistry.[1-2] These tools offer potential benefits in educational support, academic writing, case scenario analysis, and knowledge retrieval. With innovations in multimodal AI capabilities—where models process text, images, and other input types—the scope of AI applications continues to expand, offering potential utility in dental education and clinical decision

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support but also raise novel ethical and competency challenges.[3]

In dentistry, several AI tools are being used or explored for educational and clinical purposes. Students are increasingly engaging with general AI chatbots (e.g., ChatGPT, Gemini, Bard) to assist with academic writing, learning complex concepts, and preparing for examinations, while specialized applications (such as AI-assisted radiographic interpretation and diagnostic algorithms) are evolving to augment clinical workflow and diagnostic accuracy, although concerns about accuracy, overreliance, and academic integrity persist.[4] A recent narrative review highlighted the growing interest in LLMs in dental pedagogy, noting their capacity to augment personalized learning and assist in complex tasks such as periodontal charting or case reasoning, while also underscoring the importance of responsible integration and validation.[3],[5]

Several cross-sectional studies conducted internationally have begun to evaluate dental students' perspectives on AI technologies. In studies from diverse regions, dental students demonstrated variable levels of awareness and generally positive attitudes toward AI's potential in education and clinical practice, alongside concerns about ethical implications and the need for curriculum development.[6] A recent survey reported that a majority of dental students believed AI to be useful for educational and research purposes, though perceptions regarding accuracy and the possibility of replacing human expertise differed across cohorts.[7] These findings align with earlier research indicating that while students are enthusiastic about AI's promise, actual knowledge about specific AI tools and their limitations remains uneven.[8]

Despite this, there is limited empirical evidence on how dental students perceive and utilize the variety of available AI tools, including their perceived benefits, limitations, and readiness to integrate them into education and future practice. A recent cross-sectional survey in South India noted that dental students exhibited gaps in knowledge and practice related to AI in dentistry, indicating scope for enhanced training and structured exposure.[9] Another Indian study evaluating use of a specific AI model (ChatGPT) among dental students and faculty found varied levels of awareness and utilization patterns, with postgraduate students reporting higher engagement with the tool.[10]

Given the rising prominence of AI tools and the need for dental graduates to engage with evolving educational technologies, understanding the patterns of AI tool utilization, along with attitudes toward their educational and professional relevance, is essential. This understanding can inform curriculum development, foster responsible adoption, and align training with emerging technological trends. Therefore, this study aims to assess the utilization of diverse AI tools available to dental students and to evaluate their awareness, perceptions, and attitudes toward incorporating these technologies into dental education and future clinical practice.

MATERIALS AND METHODS

A cross-sectional questionnaire-based study was conducted among undergraduate (BDS) and postgraduate (MDS) dental students enrolled in a private dental college. BDS and MDS students currently enrolled in the dental college and those who provided informed consent to participate were included in the study whereas students unwilling to participate and incompletely filled questionnaires were excluded. Informed consent was obtained from all after explaining the purpose of the study. Ethical approval was obtained from the Institutional Ethics Committee of the private dental college. No personal identifiers were collected, and confidentiality of all participants was strictly maintained throughout the study. A convenience sampling method was employed. All eligible BDS and MDS students present during the period of data collection were invited to participate in the study. Students who met the inclusion criteria and provided informed consent were included in the study.

Sample Size: The sample size was calculated using the formula: $n = Z^2pq/d^2$

The anticipated proportion (p) was taken to be 50% and the allowable error (d) was set at 5%. Thus, the minimum required sample size was calculated to be 384 students. To account for potential non-response or incomplete questionnaires, the total sample size taken was 425.

Study Tool and Data Collection: Data were collected using a structured, self-administered questionnaire designed to assess awareness, utilization, and perception of commonly available AI tools used for academic and professional purposes. The questionnaire consisted of four sections: Sociodemographic and academic characteristics, second-Awareness of artificial intelligence tools, third-Utilization of AI tools in dentistry and fourth-Perception and attitudes toward AI tools. Responses were recorded using multiple-choice questions and 3-point Likert scale items (ranging from agree to disagree). The questionnaire was administered

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by the investigator and collected during the same academic period to ensure completeness. Participation was voluntary, and anonymity was maintained.

Questionnaire Validation and Pilot Testing: The questionnaire was reviewed by a panel of five subject experts in dental public health to assess content relevance, clarity, and appropriateness. Based on their suggestions, minor modifications in wording and sequencing of items were made prior to final administration. Content validity was evaluated using the Content Validity Index (CVI), which demonstrated an overall scale-level CVI of 0.89, indicating good content validity. A pilot study was subsequently conducted among 30 dental students who were not included in the final sample to evaluate comprehensibility, feasibility, and average response time. The questionnaire required approximately 8–10 minutes to complete. Internal consistency of the perception and utilization domains was assessed using Cronbach's alpha, which yielded a value of 0.82, indicating good reliability.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using appropriate statistical software. Descriptive statistics were used to summarize awareness, utilization patterns, and perceptions regarding AI tools. Inferential statistical tests were applied to assess associations between AI tool utilization and selected variables such as program of study (BDS/MDS), year of study, and prior exposure to AI. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 408 dental students participated in the study, comprising 336 (82.4%) undergraduate (BDS) students and 72 (17.6%) postgraduate (MDS) students. With respect to age distribution, the largest proportion of participants belonged to the 22–24 years age group (44.6%), followed by those aged 25–27 years (19.1%). Students aged 21 years or younger constituted 25.5% of the sample, while participants aged 28 years and above accounted for 10.8%, the majority of whom were postgraduate students. Female students represented a higher proportion of the study population (56.9%) compared to male students (43.1%). Among BDS students, females constituted 60.1% of participants, whereas among MDS students, males were more frequently represented (58.3%). Regarding exposure to artificial intelligence, nearly half of the participants (48.5%) reported social media and other online platforms as their primary source of information about AI. Faculty-led or institutional teaching was reported by 18.1% of students overall and was more commonly cited among MDS students compared to BDS students. Peer discussions accounted for 20.1% of AI information sources, while 13.2% of participants reported self-learning through resources such as blogs, online videos, or independent study materials. [Table 1]

Awareness of artificial intelligence tools was high among both BDS and MDS students; however, MDS students demonstrated significantly higher awareness across most AI platforms. ChatGPT was the most widely recognized AI tool, with 89.9% of BDS students and 97.2% of MDS students reporting awareness, and this difference was statistically significant ($p = 0.041$). Awareness of Google Gemini was reported by 65.5% of BDS students and 80.6% of MDS students, showing a significant difference between the two groups ($p = 0.015$). Similarly, awareness of Microsoft Copilot was significantly higher among MDS students (66.7%) compared to BDS students (39.9%) ($p < 0.001$). Awareness of Bard and other AI tools (including Claude and Perplexity) was also significantly greater among MDS students than BDS students ($p = 0.006$ and $p = 0.004$, respectively). [Table 2]

Utilization of AI tools varied according to the purpose of use and level of study. For academic learning, frequent use of AI tools was reported by 29.2% of BDS students and 44.4% of MDS students, with the difference being statistically significant ($p = 0.008$). Similarly, frequent use for examination preparation was higher among MDS students (41.7%) compared to BDS students (31.0%) ($p = 0.021$). In relation to literature searching, 36.1% of MDS students reported frequent use of AI tools, compared to 22.6% of BDS students, indicating a significant difference between the groups ($p = 0.003$). Utilization for research and writing assistance was also significantly higher among MDS students, with 38.9% reporting frequent use, compared to 22.0% of BDS students ($p = 0.001$). Use of AI tools for clinical decision support was limited overall; however, MDS students reported significantly higher frequent use (22.2%) compared to BDS students (7.7%) ($p < 0.001$). Across all activities, BDS students more commonly reported occasional use, while MDS students demonstrated higher proportions of frequent use. [Table 3]

Perceptions toward AI tools were generally positive among both groups, with notable differences between BDS and MDS students. Agreement that AI tools enhance learning efficiency was reported by 75.0% of BDS students and 88.9% of MDS students, with this difference being statistically significant ($p = 0.002$). Similarly, 77.8% of MDS students agreed that AI

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improves understanding of dental concepts, compared to 70.2% of BDS students (p = 0.041). Regarding the role of AI in supporting clinical decision-making, a significantly higher proportion of MDS students (72.2%) agreed with this statement compared to BDS students (48.2%) (p < 0.001). Ethical concerns related to AI use were reported by both groups; however, a greater proportion of BDS students (66.7%) expressed such concerns compared to MDS students (52.8%) (p = 0.018). Willingness to use AI tools in future dental practice was reported by 66.1% of BDS students and 83.3% of MDS students, with the difference being statistically significant (p = 0.001). Neutral responses were observed across both groups for several perception items, indicating uncertainty or cautious attitudes among a subset of participants. [Table 4]

Comparison of composite scores revealed significant differences between BDS and MDS students. The mean awareness score among BDS students was 6.9 ± 1.8, while MDS students demonstrated a significantly higher mean score of 8.3 ± 1.3 (p < 0.001). Similarly, the mean utilization score was significantly higher among MDS students (9.8 ± 2.0) compared to BDS students (7.4 ± 2.5) (p < 0.001). Perception scores also differed significantly between the groups, with MDS students reporting a higher mean perception score (16.1 ± 2.7) than BDS students (14.3 ± 3.2) (p = 0.001). These findings indicate greater awareness, more frequent utilization, and more favourable perceptions of AI tools among postgraduate dental students compared to undergraduates. [Table 5]

Table 1. Distribution of Participants by Program

Variable	*Category*	*Total n (%)*	*BDS = 336 n (%)*	*MDS = 72 n (%)*
Age group (years)	≤21	104 (25.5)	104 (31.0)	0 (0)
	22–24	182 (44.6)	182 (54.2)	0 (0)
	25–27	78 (19.1)	40 (11.9)	38 (52.8)
	≥28	44 (10.8)	10 (3.0)	34 (47.2)
Gender	Male	176 (43.1)	134 (39.9)	42 (58.3)
	Female	232 (56.9)	202 (60.1)	30 (41.7)
Primary source of AI information	Social media / online platforms	198 (48.5)	170 (50.6)	28 (38.9)
	Faculty / institutional teaching	74 (18.1)	52 (15.5)	22 (30.6)
	Peers	82 (20.1)	70 (20.8)	12 (16.7)
	Self-learning resources	54 (13.2)	44 (13.1)	10 (13.9)

Table 2. Awareness of AI Tools Among BDS and MDS Students

AI Tool	*BDS n (%)*	*MDS n (%)*	*p-value*
ChatGPT	302 (89.9)	70 (97.2)	0.041
Google Gemini	220 (65.5)	58 (80.6)	0.015
Microsoft Copilot	134 (39.9)	48 (66.7)	<0.001
Bard	126 (37.5)	40 (55.6)	0.006
Other AI tools	92 (27.4)	32 (44.4)	0.004

Table 3. Utilization of AI Tools for Academic and Dental-Related Activities

Purpose of Use	*Program*	*Never n (%)*	*Occasionally n (%)*	*Frequently n (%)*	*p-value*
Academic learning	BDS	42 (12.5)	196 (58.3)	98 (29.2)	0.008
	MDS	4 (5.6)	36 (50.0)	32 (44.4)	
Exam preparation	BDS	56 (16.7)	176 (52.4)	104 (31.0)	0.021
	MDS	8 (11.1)	34 (47.2)	30 (41.7)	
Literature search	BDS	104 (31.0)	156 (46.4)	76 (22.6)	0.003
	MDS	14 (19.4)	32 (44.4)	26 (36.1)	
Research / writing	BDS	124 (36.9)	138 (41.1)	74 (22.0)	0.001
	MDS	18 (25.0)	26 (36.1)	28 (38.9)	
Clinical decision support	BDS	208 (61.9)	102 (30.4)	26 (7.7)	<0.001
	MDS	30 (41.7)	26 (36.1)	16 (22.2)	

Table 4. Perception and Attitudes Toward AI Tools

Statement	*Program*	*Agree n (%)*	*Neutral n (%)*	*Disagree n (%)*	*p-value*
AI enhances learning efficiency	BDS	252 (75.0)	54 (16.1)	30 (8.9)	0.002
	MDS	64 (88.9)	8 (11.1)	0 (0)	
AI improves understanding	BDS	236 (70.2)	72 (21.4)	28 (8.3)	0.041
	MDS	56 (77.8)	10 (13.9)	6 (8.3)	
AI supports clinical decisions	BDS	162 (48.2)	104 (31.0)	70 (20.8)	<0.001
	MDS	52 (72.2)	14 (19.4)	6 (8.3)	
Ethical concerns exist	BDS	224 (66.7)	76 (22.6)	36 (10.7)	0.018
	MDS	38 (52.8)	20 (27.8)	14 (19.4)	
Willingness to use AI in future	BDS	222 (66.1)	76 (22.6)	38 (11.3)	0.001
	MDS	60 (83.3)	10 (13.9)	2 (2.8)	

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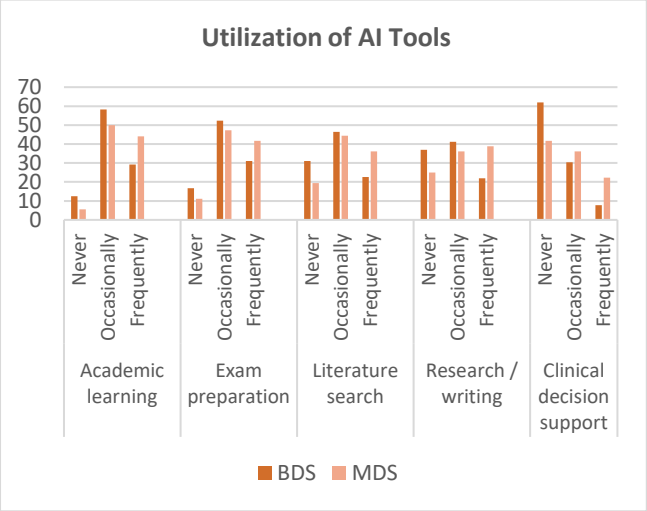
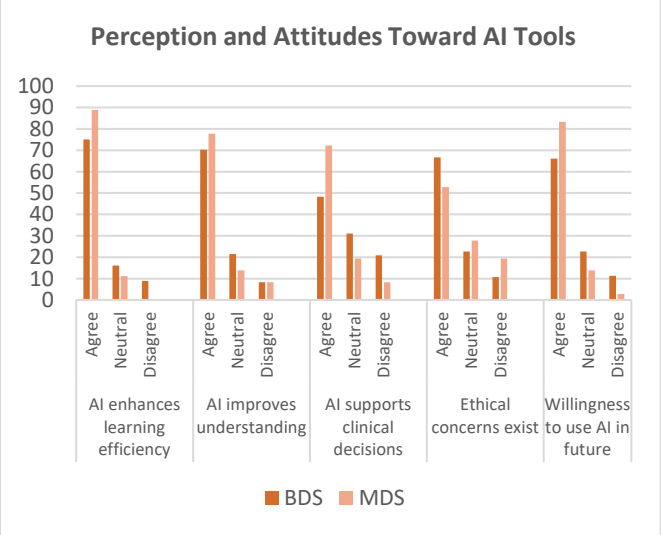
Table 5. Comparison of Composite Scores Between BDS and MDS Students

Score	BDS (Mean ± SD)	MDS (Mean ± SD)	p-value
Awareness score (0–10)	6.9 ± 1.8	8.3 ± 1.3	<0.001
Utilization score (0–15)	7.4 ± 2.5	9.8 ± 2.0	<0.001
Perception score (0–20)	14.3 ± 3.2	16.1 ± 2.7	0.001

Graph 1: Utilization of AI Tools among study participants



Graph 2: Perception and Attitudes of study participants towards AI Tools



DISCUSSION

The present cross-sectional study assessed the awareness, utilization, and perception of artificial intelligence (AI) tools among undergraduate and postgraduate dental students. The findings revealed high overall awareness, predominantly academic-focused utilization, and generally positive perceptions, with significantly greater engagement among postgraduate students. These observations align with emerging global evidence indicating increasing exposure of dental learners to AI-enabled technologies and digital learning tools.[11]

Awareness of AI tools

In the current study, awareness of conversational AI platforms such as ChatGPT was notably high. Recent literature similarly reports rapid penetration of generative AI tools among health-profession students due to their accessibility and academic usefulness.[2] Studies from dental education settings have demonstrated that students frequently become aware of AI through informal digital environments rather than structured curricula, highlighting a gap between exposure and formal training.[12] Higher awareness among postgraduate students observed in this study is consistent with findings that advanced academic engagement and research involvement are associated with greater familiarity with emerging digital technologies.[13]

Utilization patterns

AI utilization was mainly limited to academic learning, examination preparation, literature search, and research assistance, while clinical decision-support use remained comparatively low. Similar utilization trends have been described in recent dental and medical education research, where students primarily use generative AI for knowledge acquisition and academic productivity rather than patient-care decisions.[14] Limited clinical use may reflect concerns about reliability, medico-legal accountability, and absence of formal clinical validation, which are widely discussed barriers to AI adoption in healthcare.[15] Postgraduate students' higher research-oriented utilization observed in this study parallels prior evidence showing greater dependence on AI-supported evidence synthesis and academic writing among senior trainees.[16]

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Perception toward AI

Overall perceptions toward AI were favourable, particularly regarding learning efficiency and conceptual understanding. Comparable positive attitudes have been reported in multinational surveys of dental and medical students, where AI is viewed as a supportive educational adjunct rather than a replacement for professional judgment.[17] However, ethical concerns—including academic integrity, over-reliance, and data privacy—were also evident, consistent with contemporary discourse on responsible AI use in higher education.[18] Such concerns underscore the necessity of ethical guidance and governance frameworks when integrating AI into professional training. Greater willingness among postgraduate students to use AI in future clinical practice may reflect higher clinical confidence and exposure to decision-making environments, a trend also documented in studies comparing junior and senior healthcare trainees.[19]

CONCLUSION

The present study revealed high awareness and generally positive perceptions of artificial intelligence (AI) tools among dental students, with utilization primarily centered on academic learning, examination preparation, and research assistance, while clinical decision-support use remained comparatively limited. Postgraduate students demonstrated significantly greater awareness, more frequent utilization, and more favourable perceptions than undergraduate students, indicating that engagement with AI technologies increases with academic progression and clinical exposure. These findings highlight the growing relevance of AI within dental education and the need for its responsible and structured integration into training programs.

However, certain limitations must be acknowledged. The study was conducted in a single private dental institution, which may limit the generalizability of the findings to other academic settings. Data were self-reported, introducing the possibility of recall and response bias. Additionally, the study assessed perceived awareness and utilization rather than objective competency or clinical effectiveness of AI tools. The cross-sectional design also restricts the ability to determine temporal changes or causal relationships.

Based on these findings, it is recommended that formal AI literacy and ethics training be incorporated into undergraduate and postgraduate dental curricula, including instruction on critical appraisal, responsible academic use, and supervised clinical application of AI technologies. Future research should involve multi-institutional and longitudinal designs, evaluate objective AI competencies, and explore the impact of curriculum-based AI education on clinical decision-making and patient care outcomes. Such evidence will be essential for guiding the safe, ethical, and effective integration of artificial intelligence into dental education and practice.

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