

Perspectives of Indonesian dental practitioners on application of artificial intelligence in dentistry

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ABSTRACT

Limited evidence exists about the knowledge, attitudes, and perceptions of Indonesian dental practitioners with regard to artificial intelligence (AI). A cross-sectional survey was performed among 235 licensed dentists throughout Indonesia, assessing their attitudes on the potential benefits and barriers of AI in dentistry, and its perceived influence on their profession. A “positive attitude – knowledge gap” was observed: attitudes towards AI were very positive (79.6% good), with comparatively low levels of basic AI knowledge (54.3% good). Dentists are positive towards the impact of AI on their professional efficiency (86.4%) and accuracy (82.1%), but remain concerned over the potential barriers of its implementation, specifically the ambiguity in legal liability (82.1%), high cost (77.0%), and data security issues (71.9%). The majority of dentists do not believe that AI will replace them (65.5%), but most worry that the use of AI may erode their skills (54.9%). There is strong support for curricular change (83.4%). Overall, Indonesian dentists are amenable to AI but are currently limited by low knowledge and many AI-related barriers. To increase its adoption, future efforts should focus on promoting practitioner education, as well as increasing confidence in legal and regulatory structures.

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1. INTRODUCTION

The potential of artificial intelligence (AI) has also been of particular interest in dental care. The field has progressed from basic principles to practical applications that help different healthcare environments achieve better diagnostic precision and better treatment approaches and operational control [1]–[3]. Machine learning, and more specifically deep learning with its artificial neural network models organized in multiple nonlinear layers that help identify patterns across high-dimensional data sets, currently constitutes the backbone of most of these modern AI applications in medicine [4]–[12].

AI technology enables deep learning models to perform dental applications through various architectures that deliver specific functions for dental practice [2], [8], [13], [14]. Radiographic dental analysis depends on convolutional neural networks (CNNs) as its main AI tool because these networks replicate biological data processing systems [5], [13], [15]–[17]. The technology operates at such precise levels that medical professionals now use it to help diagnose caries and periodontal bone loss and multiple

other pathologies [1], [18]–[20]. The application of natural language processing (NLP) technology enables computers to extract human language data from unstructured text, which now supports automated administrative work and electronic health record (EHR) note summarization and practice management optimization [1], [21]–[23]. The two main systems of AI algorithms in dental practice use diagnostic operations and administrative tasks to create personalized treatment plans for orthodontic and implantology procedures [1], [2], [24].

The potential of these AI tools to improve patient outcomes and make dental practices run more smoothly and profitably is significant, but their uptake is by no means universal and faces substantial barriers [5], [25]–[28]. One of the most pressing problems, for instance, is the serious ethical and legal issues that this technology raises [5], [29]–[32]. How to ensure the security of patient data that is needed to train and validate AI systems and guarantee the privacy of this information, how to ensure the security of AI systems themselves, and even the question of liability for diagnostic and treatment recommendations made by an AI are all significant challenges for which, in most cases, formal regulations are still lacking [29], [30].

In addition, it is not uncommon to find among the professionals working in the field a palpable feeling of anxiety about what the arrival of this technology will mean for their job [33]–[35]. Increasingly, some professionals fear a potential loss of professional authority over clinical decision-making that is at the very core of the profession in favor of machine algorithms, as well as the risk to their own career security as a result [7], [30]–[34]. The technology encounters various obstacles for large-scale adoption because of psychological and professional hurdles, expensive implementation costs, and training needs [5], [7], [30], [36].

Promoting a responsible use of AI in dentistry and addressing these challenges will therefore require understanding the point of view of the professionals expected to use it on a day-to-day basis, and to that end, a number of surveys and studies have been carried out. The available evidence is limited, and especially in Indonesia, little is known about the assessment of the knowledge, attitudes and perceptions of dental professionals on AI. This study aims to address this gap. Its objectives are to: i) determine the current level of knowledge of licensed dental practitioners on the application of AI; ii) explore the attitudes of dental practitioners to adopting AI technologies; and iii) investigate the perceptions of dental practitioners towards the expected benefits, threats and ethical considerations of the AI application.

2. METHOD

2.1. Study design

This study employed a cross-sectional, descriptive survey design using a self-administered online questionnaire to examine dental professionals' engagement with AI. A quantitative methodology was adopted to systematically collect data on three key domains: practitioners' knowledge of AI applications, their attitudes toward adopting the technology, and their perceptions regarding its benefits and risks in dental practice. This design was chosen because it allows for the efficient collection of standardized responses from a geographically dispersed population within a defined time frame, making it well suited for capturing a snapshot of the current landscape across Indonesia.

2.2. Study population and sampling

The population of interest in this research was all the dental practitioners in Indonesia who had a dental license in their name, either as a general practitioner or from different dental specialties. The sample size was calculated using standard formula for cross-sectional studies: $n = (Z \alpha/2)^2 \times P(1 - P) / d^2$. A confidence level of 95% was used, and the expected prevalence of knowledge and attitudes was conservatively assumed at 50% (0.5). A final sample of 235 was obtained, providing a margin of error of about 6.4% at 95% confidence level.

2.3. Data collection instrument

The data collection tool was an online questionnaire via Google Forms, distributed in Indonesian and translated to English for analysis. It had four parts. Part A collected demographic info including age, gender, years in practice, and professional specialty; part B tested AI knowledge with scores below 75 labeled as not good and 75 or above as good; part C used a 4-point Likert scale (excluding neutral) to gauge attitudes towards AI adoption; part D, also on a 4-point scale, assessed perceptions of AI's benefits, risks, and ethics.

2.4. Data collection

Professional dental networks distributed the anonymous Google Forms questionnaire through social media platforms like WhatsApp, Instagram, and specialized dental groups and email lists. The data collection period spanned from July to August 2025. The first survey page displayed an informed consent

document that described the research objectives, guaranteed both anonymity and confidentiality and clarified voluntary participation status. Progressing to the questionnaire indicated that the participant consented to participate.

2.5. Statistical analysis

The survey responses were exported from Google Forms into Microsoft Excel after the data collection period finished. The researcher will apply descriptive statistics including frequencies and percentages along with means and standard deviations to present participant demographic information and questionnaire responses. The researchers will conduct thematic analysis from that synthesis of results.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. The demographic and professional characteristics of respondents

In this cross-sectional study, 235 licensed dental practitioners in Indonesia participated in the questionnaire. The demographic and professional characteristics of the respondents are shown in Table 1. The sample was predominantly female (63.8%, $n = 150$), and the largest age group was 31–40 years old (41.7%, $n = 98$), indicating that most respondents were in the middle stages of their careers. Clinical experience was more varied: the largest group had over 20 years of experience (31.9%, $n = 75$), followed by those with 0–5 years (27.2%, $n = 64$), 6–10 years (21.7%, $n = 51$), and 11–20 years (19.1%, $n = 45$).

Table 1. Characteristics of study participants ($n = 235$)

Characteristics	Category	Frequency	Percentage (%)
Gender	Male	85	36.2
	Female	150	63.8
Age (years old)	20-30	48	20.4
	31-40	98	41.7
	41-50	35	14.9
	51 – 60	24	10.2
	Over 60	30	12.8
Length of practice (years)	0 – 5	64	27.2
	6 – 10	51	21.7
	11 – 20	45	19.1
	Over 20	75	31.9

3.1.2. The general evaluation of knowledge, attitude, and perception

Figure 1 presents the general evaluation of the participants' knowledge, attitudes, and perception in the use of AI in dentistry. The participants were evenly split in terms of knowledge, with 54.3% ($n = 129$) of the sample being labelled as “good” while the other 45.7% ($n = 106$) were labelled as “not good”. In terms of the respondents' attitudes, the vast majority of practitioners were in the “good”/positive category, with 79.6% ($n = 187$) of respondents being so rated while 20.4% ($n = 48$) were not. The final category, the participants' perception, was more evenly divided than the last, with 59.6% ($n = 140$) of participants being “good” and the other 40.4% ($n = 95$) being “not good”.

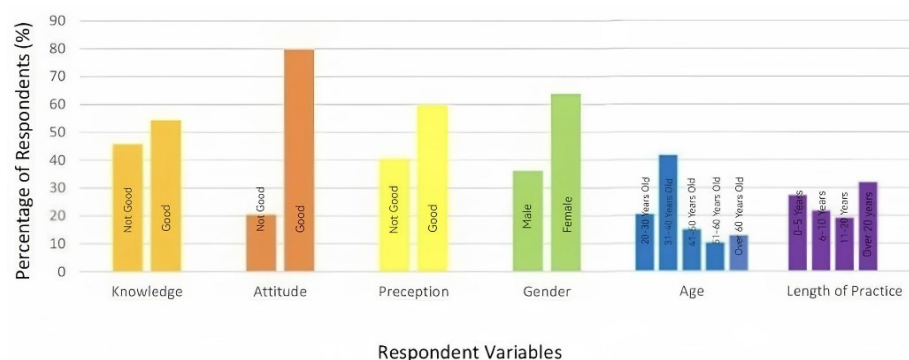


Figure 1. The distribution of the subjects based on variables ($n = 235$)

3.1.3. Detailed analysis of attitudes and perceptions

To gain a more nuanced understanding of the respondents' views, participants were presented with an additional 14 items rated on a 4-point Likert scale ranging from "strongly disagree" to "strongly agree" (Table 2). These items were designed to capture specific dimensions of attitudes and perceptions toward AI in dentistry, including enthusiasm for its potential, concerns about clinical dependence, and expectations regarding diagnostic accuracy and patient care. The distribution of responses across all 14 items is presented in Table 2 and further visualized in Figure 2, allowing for a detailed, item-level examination of where practitioners' opinions converged and diverged.

Table 2. Dental practitioners' responses to attitudes and perceptions regarding AI (n = 235)

No.	Question	Strongly disagree		Disagree		Agree		Strongly agree	
		n	%	n	%	n	%	n	%
1	I am excited about AI's potential to improve dental care.	1	0.42	19	8.08	110	46.8	105	44.68
2	I believe AI will make the daily tasks of a dental practitioner more efficient.	2	0.85	30	12.76	105	44.68	98	41.7
3	I am willing to invest in AI for my dental practice.	10	4.25	75	31.91	105	42.12*	51	21.7
4	In my opinion, the process of learning AI-based systems will be difficult and time-consuming.	31	13.19	11	49.36	68	28.93	20	8.51
5	I am concerned that reliance on AI may lead to a decline in my clinical skills.	32	13.61	74	31.48	75	31.91	54	22.97
6	AI will significantly improve diagnostic accuracy in dentistry.	4	1.7	38	16.17	128	54.46	65	27.65
7	AI will result in more personalized and predictable care outcomes for patients.	5	2.12	37	15.74	128	54.46	65	27.65
8	AI can help reduce the rate of human error in clinical practice.	4	1.7	41	17.44	132	56.17	58	24.68
9	I am concerned that AI may eventually replace some of the roles of a dental practitioner.	61	25.95	93	39.57	48	20.42	33	14.04
10	The high cost of AI technology is a major barrier to its adoption in my practice.	12	5.1	42	17.87	101	42.97	80	34.04
11	AI will threaten the autonomy and decision-making power of dentists.	53	22.55	90	38.29	57	24.25	35	14.89
12	I am concerned about the security and privacy of patient data used by AI systems.	12	5.1	54	22.97	94	40	75	31.91
13	It is unclear who would be legally liable (the dentist, AI developer, or device supplier) if the AI system makes a diagnostic or treatment error.	16	6.8	26	11.06	77	32.76	116	49.36
14	I feel that lessons on AI in dentistry need to be included in the undergraduate dental curriculum.	5	2.12	34	14.46	113	48.08	83	35.31

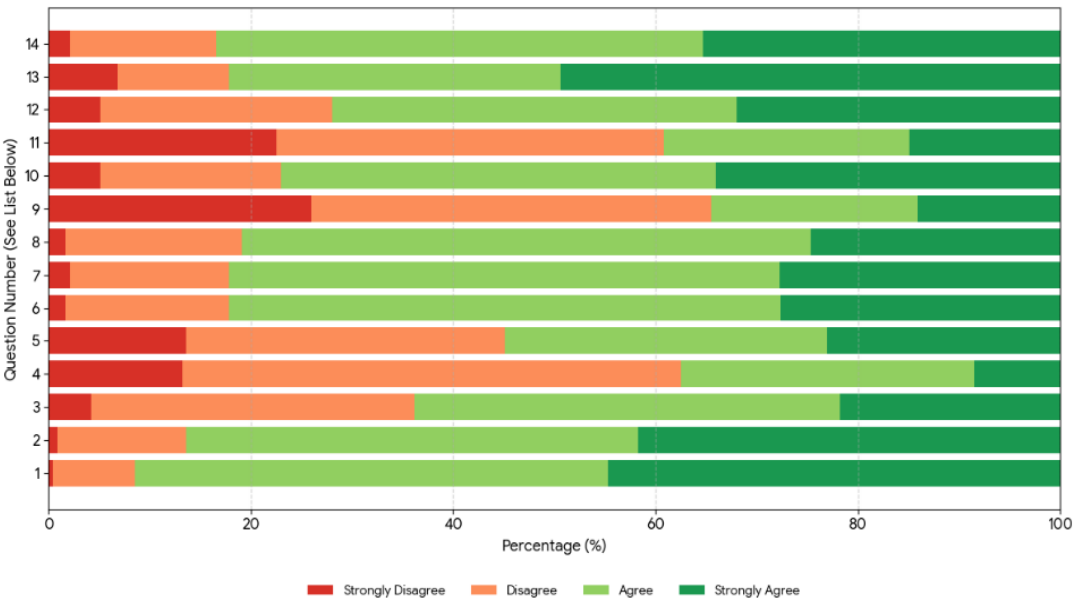


Figure 2. Percentage distribution of agreement levels for 14 statements regarding AI in dental care (n = 235)

3.1.4. Perceived benefits of artificial intelligence for clinical practice

Respondents expressed strong support for AI's positive impact on dental practice and patient care. 91.5% were excited about AI improving dental care, with 46.8% 'agreed' and 44.7% 'strongly agreed'. Similarly, 86.4% believed AI would make practitioners' daily work more efficient. A total of 82.1% agreed or strongly agreed that AI would enhance diagnostic accuracy and make outcomes more personalized and predictable. Additionally, 80.8% agreed AI could reduce human errors in clinical practice.

3.1.5. Concerns about implications of artificial intelligence for professional practice

Responses about AI's impact on practitioners' roles were mixed. About 54.9% believed AI reliance could reduce clinical skills, while 45.1% disagreed. Most (65.5%) disagreed that AI threatens their profession, and 60.8% did not see AI as threatening their autonomy in dental practice.

3.1.6. Impediments to implementation: economic, ethical and legal

Beyond professional roles and identity, the data revealed key concerns about the broader implementation of AI in dental practice. The first related to cost: 77.0% of participants either "agreed" or "strongly agreed" that high price is a major impediment to AI technology. In addition to financial challenges, there were key concerns related to data governance and ethical factors. A majority 71.9% of respondents were concerned about security and privacy around patient data being used by AI systems ("agree" 40.0%, "strongly agree" 31.9%). The most marked concern was legal uncertainty: 82.1% of practitioners "agreed" (32.8%) or "strongly agreed" (49.4%) that it was unclear who would be legally responsible – the dentist, the AI developer, or the device supplier – if an AI system made a diagnostic or treatment error.

3.1.7. Willingness and readiness for artificial intelligence: practical and educational implications

Despite these impediments, the findings suggest a high level of willingness and readiness among practitioners. The majority of the sample (63.8%) "agreed" (42.1%) or "strongly agreed" (21.7%) that they would consider spending money on AI for their practice. Moreover, 62.6% of the sample "disagreed" or "strongly disagreed" that AI-based systems would be difficult and time-consuming to learn, suggesting little concern about the learning curve. The findings also revealed a strong preference for educational reform: 83.4% of respondents felt that there should be lessons on AI in dentistry as part of the undergraduate dental curriculum ("agree" 48.1%, "strongly agree" 35.3%).

3.2. Discussion

This study provides the first comprehensive assessment of Indonesian dental practitioners' perspectives on AI integration. The main finding is a community on the verge of adopting transformative technology but facing a significant "attitude-knowledge" gap. While 79.6% have a positive attitude towards AI, only 54.3% have good knowledge, and 59.6% view AI positively overall. This indicates a community eager to embrace technology but lacking understanding. The positive outlook is tempered by negative views on costs, data security, and legal issues. The profession is ready for technological change but hindered by knowledge gaps and practical challenges.

3.2.1. A landscape of optimism tempered by pragmatism: Indonesian perspective in a global context

The clear positive attitude towards AI, especially its potential to improve diagnostic accuracy (82.1%) and efficiency (86.4%), is largely consistent with global trends in healthcare professions. Optimism about these benefits has been reported among dental professionals in other contexts, such as among Saudi Arabia dentists and international dental students [2], [19]. The enthusiasm is, once again, not limited to dentistry; physicians in medicine broadly have also noted that AI will substantially benefit them and improve their work [5], [13], [37]–[40].

However, a significant disconnect between attitude and knowledge emerges as one of the key takeaways of this study. The sizeable "not good" percentage for the questions on knowledge (45.7%) and perception of AI in the dental profession (40.4%) suggests an optimism that may be rooted less in a detailed understanding of AI technologies and more in a general familiarity with technological trends. A significant gap in AI knowledge has also been flagged as a major hurdle in other studies of healthcare professionals, leading them to a perceived state of unpreparedness for AI in their workplaces [29], [30], [36]. The Indonesian situation is made unique by an eagerness to embrace AI tempered by an urgent need for foundational education, further nuanced by a clear-eyed view of the systemic barriers to implementation. A consensus emerges on the challenges posed by the costs (77.0%), data privacy (71.9%), and legal liability (82.1%). This awareness of practical barriers seems to hold true even for those without a deep technical understanding of the AI at issue. These issues are also frequently cited in healthcare settings as some of the main barriers to AI adoption in the short- to medium-term, framing the problem as one of policy and governance, not merely professional acceptance [5], [13], [19], [41], [42].

3.2.2. The future of the dental professional in the age of AI: augmentation over replacement

The key finding about AI and the future role of the dentist is the overwhelming agreement that AI will not replace the profession. The strong disagreement with the statement that AI will replace dentists in the future (65.5%) or that it will significantly threaten the autonomy of the profession (60.8%) suggests that the profession has a nuanced understanding of the technology as a tool of support rather than a threat. This mirrors findings from other settings, where Swiss dentists perceive AI not as a replacement but as a tool that will demand and improve the quality of their oversight [7]. A similar view of the technology as a supportive tool rather than a threat has also been expressed by Swiss physicians and international dental students [2], [7]. Moreover, some Indonesian practitioners harbor reservations that over-reliance on AI tools may erode their skills: the majority (54.9%) were concerned that AI will negatively affect their ability to make important clinical decisions. This suggests a fear not of redundancy but of over-dependence and loss of clinical acumen, an established pattern known as skill degradation or “deskilling” in which the consistent delegation of cognitive tasks to automated systems erodes human expertise [43]–[45]. Through the underlying process of “cognitive disengagement”, practitioners who outsource their mental processes to AI are deprived of the mechanisms that train, stimulate, and retain clinical reasoning and memory consolidation [43]–[45].

This is not a threat to jobs but rather to professional integrity and independence, as skill erosion would lead to increased dependence on the very tools one might have once viewed as supportive [43], [45]. This frames the issue not as existential but as one of responsible implementation and continuous professional development in an age of rapidly advancing technologies. The role of the dentist, in this view, is evolving from that of the sole analyst and decision-maker to that of the supervisor and interpreter of AI-generated data. It is, however, a role that still demands the clinical acumen, deep knowledge, and clinical expertise of a seasoned practitioner. Indonesian dental practitioners are thus positioning themselves as the master, not the servant, of their tools. This is further confirmed by the lack of disagreement with the statement that AI will never replace the human elements of empathy and communication, which are seen as the most difficult for machines to replicate, with health professionals such as nurses also sharing this sentiment [21], [46], [47].

3.2.3. Implications for policy, education, and practice

The implications of this study for stakeholders in the Indonesian dental ecosystem are clear and consistent. The significant gap in AI knowledge (45.7% “not good”) coupled with overwhelming agreement (83.4%) with the statement that AI should be included in the undergraduate dental curriculum is a powerful call for urgent and substantive educational reform. This is consistent with findings from studies of dental students and other healthcare professionals, who understand that future-proofing the profession must start with the education of its next generation [2], [6]. The inclusion of AI education into undergraduate curricula is an urgent and inescapable step towards ensuring that the next generation of dentists can not only use these tools but also critically evaluate, ethically deploy, and responsibly utilize them as they mature [48], [49].

Second, the research also shows that professional education alone is not enough. The way to AI adoption is impeded by a systemic readiness gap that only policymakers and professional bodies can address. The findings suggest a profession ready to learn (62.6% do not perceive learning AI as difficult) and ready to pay (63.8% are willing) but justifiably hesitant in a regulatory void. As such, the most urgent priority should be the creation of a comprehensive national framework for AI in healthcare. This framework should include, at a minimum, standard specifications for data privacy and, most importantly, an unambiguous legal framework for liability [5], [18], [19], [50]. Without the guardrails, the enthusiasm of practitioners will be left unfulfilled.

For these reasons, the move towards AI adoption in Indonesia must be two-pronged, and must work not just to equip the profession with the know-how but also to build a safe and secure environment within which these skills can be deployed to their fullest potential. This shifts responsibility from individual practitioners to one shared among policymakers, dental education authorities, dental associations, and dental schools. The most pressing priority is the establishment of clear national guidelines on the ethical use of AI in healthcare, data privacy standards, and the legal framework for liability [18], [19]. Such guidelines must be spearheaded by the Indonesian government to provide the regulatory clarity on which innovation depends.

3.2.4. Strengths and limitations

The main strength of the study is its novelty: to our knowledge, it is the first to systematically survey the knowledge, attitudes, and perceptions of Indonesian licensed dental practitioners regarding AI, filling a gap in the literature. The structured questionnaire with quantitative results also allows a ready

assessment of those perspectives and enables comparison with similar international studies. The study, of course, is not without limitations. First, the cross-sectional design provides only a static “snapshot” of opinions at one point in time. Opinions about such a rapidly evolving technology are likely to shift over time. Second, the online format of the questionnaire, together with its distribution through professional channels, is subject to some selection biases as it comprises a convenience sample. Practitioners more invested in technological change were more likely to be reached through these channels and to complete the questionnaire. Finally, the sample size is small relative to the target population, which compromises the generalizability of the findings and precludes subgroup analyses (e.g., by age or years of practice) that could have provided more nuanced results.

4. CONCLUSION

This study shows Indonesian dental practitioners are optimistic about AI enhancing dental care, but their confidence is fragile due to limited knowledge and concerns over costs, data security, and legal clarity. They see AI as a tool to improve oversight, not replace clinicians. To safely incorporate AI, future efforts must build a secure ecosystem and expand education. Further research should replicate and follow up on this study, especially qualitative studies to explore practitioners' hopes and expectations.

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C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The research has been approved by the Universitas Airlangga Health Research Ethical Clearance Commission with number 0797/HRECC.FODM/VII/2025.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [ID], upon reasonable request.

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