Submitted: 14 May, 2025 Accepted: 30 June, 2025 Published: 03 May, 2026 DOI:10.22514/jocpd.2026.062

ORIGINAL RESEARCH

Journal of Clinical Pediatric Dentistry

AI integration in pediatric dentistry: perspectives from Saudi Arabia, Malaysia, and Pakistan

Nishath Abdul Sayed[1], Zeeshan Qamar[2,*], Auj Tameer Islam[3], Nada Mustafa Abu-Zayed[3], Sara Ayman Yousef[3], Manar Ghazi Altoukhi[3], Leena Abdullah AlAmri[4], Zahra Muneer AlSaffar[4], Cristalle Soman[5], R Naveen Reddy[6], Mohammed Ahmed Mohammed Khder[3]

[1]Department of OMFS and Diagnostic Sciences (Oral Pathology), College of Medicine & Dentistry, Riyadh Elm University, 12734 Riyadh, Saudi Arabia
[2]Department of O&MFS and Diagnostic Sciences, College of Medicine & Dentistry, Riyadh Elm University, 12734 Riyadh, Saudi Arabia
[3]College of Medicine & Dentistry, Riyadh Elm University, 12734 Riyadh, Saudi Arabia
[4]College of Dentistry, Dar Al Uloom University, 13314 Riyadh, Saudi Arabia
[5]Department of OMFS & DOS, College of Medicine & Dentistry, Riyadh Elm University, 12734 Riyadh, Saudi Arabia
[6]Department of Prosthodontics, College of Dentistry, Jazan University, 45142 Jazan, Saudi Arabia

***Correspondence**
zeeshan.qamar@riyadh.edu.sa
(Zeeshan Qamar)

Abstract

Background: The integration of artificial intelligence (AI) into dentistry holds immense potential to enhance diagnostic accuracy, treatment planning, and patient outcomes, particularly in pediatric care. Despite its promise, the adoption of AI in routine dental practice remains slow, with challenges such as ethical concerns, lack of training, and high costs hindering progress. This study explores the awareness, attitudes, and current adoption of AI in pediatric prosthodontics and oral medicine among dental professionals in Saudi Arabia (SA), Malaysia (MY), and Pakistan (PK), aiming to identify barriers and opportunities for AI integration in child-focused dental care. **Methods**: A cross-sectional survey was conducted among 655 pediatric dentists (SA: 231, MY: 181, PK: 243) using a structured online questionnaire. The survey assessed demographics, knowledge of AI applications, attitudes toward AI integration, current clinical practices, and perceived barriers. Data were analyzed using descriptive statistics, chi-square tests, and logistic regression to evaluate regional differences and predictors of AI adoption. **Results**: Awareness of AI applications was highest in MY (95.6%), followed by PK (85.6%) and SA (78.8%). While most respondents viewed AI positively—believing it could improve treatment outcomes (92.6–97.1%)—actual usage was low (SA: 16.5%, MY: 37.6%, PK: 9.9%). Key barriers included cost, lack of training, and resistance to change. Logistic regression revealed significant regional disparities, with MY showing higher adoption rates than SA and PK ($\rho < 0.001$). Despite enthusiasm, over 90% of dentists emphasized the need for human oversight in AI-based diagnoses. **Conclusions**: Pediatric dentists acknowledge the potential of AI; however, its practical implementation is hindered by systemic and regional challenges. It is crucial to implement targeted interventions, including the development of affordable AI tools, the establishment of specialised training programs, and the formulation of ethical guidelines. Collaborative efforts involving policymakers, educators, and practitioners can facilitate the responsible integration of AI, enhancing precision and patient care.

Keywords

Artificial intelligence; Pediatric dentistry; Dental prosthodontics; Healthcare technology adoption; Barriers to AI integration

1. Introduction

The integration of artificial intelligence (AI) into healthcare is rapidly transforming various medical specialties, and dentistry is no exception [1]. AI's potential to enhance diagnostic accuracy, treatment planning, and administrative efficiency is garnering significant attention within the dental community [1, 2]. As technology continues to advance, AI demonstrates the ability to process extensive datasets and emulate human cognitive functions, thereby influencing the healthcare sector substantially [3]. AI algorithms are expected to refine dental diagnoses, offer visualized anatomical treatment guidance, simulate and assess potential outcomes, and forecast the incidence and prognosis of oral diseases, owing to their robust data analysis capabilities [4]. The ongoing development of AI technologies in dentistry promises a future characterized by improved efficiency, precision, and patient-centric care. Virtual and augmented reality applications elevate dental education and training, enabling practitioners to hone their skills in realistic, immersive settings [5]. AI-driven robotics is also being developed for use in dental surgeries to improve precision and accuracy [6].

However, the actual adoption of AI in routine dental practice has been slower than anticipated [7]. Several obstacles, includ-

ing data curation, sharing, and readability issues; the opacity of decision-making processes within AI algorithms; inadequate computing power; and a neglect of ethical principles in AI framework design, impede the widespread implementation of AI in dentistry [4, 6]. Ethical issues surrounding patient data security, algorithm bias, and regulatory frameworks must be carefully addressed to facilitate responsible and ethical AI implementation in dentistry [5]. Further research is needed to explore the long-term effects of AI on dental practice and patient outcomes.

The aim of this research was to thoroughly investigate the awareness, attitudes, and adoption of AI in pediatric prosthodontics and oral medicine among dental professionals across Saudi Arabia (SA), Malaysia (MY), and Pakistan (PK), focusing on identifying specific barriers and opportunities for integrating AI in child-focused dental care. This involves evaluating the current understanding of AI applications, assessing perceptions of AI's potential to improve diagnostic accuracy and treatment outcomes in children, examining concerns about ethical implications, and exploring the willingness to incorporate AI into education and clinical practice.

This study also seeks to analyze the current use of AI tools in pediatric dental clinics, identify key barriers limiting AI adoption, determine which clinical areas are deemed highest priority for AI integration, and propose tailored recommendations for policymakers and educators in each region. This paper seeks to create a foundation for future research in this rapidly growing area by outlining the advancement and potential dental uses of AI in medical-aided diagnosis, treatment, and disease prediction while also discussing their data limitations, interpretability, computing power, and ethical considerations, as well as their influence on dentists [4].

2. Materials and methods

This study was designed as a descriptive, cross-sectional survey to investigate pediatric dentists' understanding, attitudes, and clinical practices surrounding the use of AI in prosthodontics and oral medicine. Dentists from SA, MY, and PK were invited to participate in the research.

2.1 Sample size calculation

The sample size was calculated prior to commencement of the study was approximately 116 respondents required from each population. The sample size (n) was calculated according to the formula: $n = [z^2 \times p \times (1 - p)/e^2]/[1 + (z^2 \times p \times (1 - p)/(e^2 \times N))]$. Where: $z = 1.96$ for a confidence level (α) of 95%, p = proportion (expressed as a decimal), N = population size, e = margin of error. $z = 1.97$, $\rho = 0.5$.

2.2 Participants and recruitment

A total of 655 pediatric dental practitioners took part in the survey, including 231 from SA, 181 from MY, and 243 from PK. Participants were selected purposefully to include both pediatric dental specialists and general dentists involved in pediatric care. Recruitment was carried out by sharing invitations through national dental associations, university networks, and professional social media platforms within each country. The participants were selected as per the strict selection criteria mentioned in Table 1.

Purposive sampling to target pediatric dental specialists and general dentists actively involved in pediatric care across Saudi Arabia, Malaysia, and Pakistan. While this approach ensured relevance to our study objectives, it may limit the generalizability of findings to broader dental populations. The sample was drawn from professional networks and associations, which could introduce selection bias, as participants may represent more technologically engaged practitioners compared to the wider dental community.

2.3 Questionnaire development

Data was collected through a structured, online questionnaire created specifically for this study. The development process included a comprehensive review of existing literature and input from subject matter experts in both pediatric dentistry and artificial intelligence. The questionnaire consisted of 17 items spread across four key sections:

(i) Demographics (4 items): Participants were asked about their gender, country of practice, job title, and years of clinical experience.

(ii) Knowledge Assessment (4 items): This section explored familiarity with AI applications relevant to pediatric prosthodontics and oral medicine. Three questions required Yes/No responses, and one used a 5-point Likert scale (ranging from strongly disagree to strongly agree) to evaluate perceptions of AI relevance and understanding.

(iii) Attitudes Toward AI (5 items): These questions assessed participants' views on integrating AI into pediatric dental care, including its potential benefits and ethical implications. Four questions used on Yes/No responses with one question was measured using a 5-point Likert scale.

(iv) Clinical Practices and Perceived Barriers (4 items): This section investigated current usage of AI in practice, routine clinical workflows, and challenges faced in adopting AI. Two questions were Yes/No items, and two included multiple-choice options to capture more detailed insights.

Higher scores on Likert-scale questions reflected stronger

TABLE 1. Exclusion and inclusion criteria of the participants.

Inclusion Criteria	Exclusion Criteria
Dental practitioners involved in pediatric dental care	Practitioners not treating the pediatric patients
Practitioners graduating from the three countries	Dental professionals graduated from countries other than Saudi Arabia, Malaysia, and Pakistan
	Individuals not involved in clinical practice

knowledge, more positive attitudes, or higher engagement with AI applications.

2.4 Pilot testing and validation

The draft questionnaire underwent pilot testing with a sample of 30 dentists—10 from each country—to confirm its clarity, cultural suitability, and relevance. Based on their feedback, minor revisions were made to enhance comprehension and accuracy. The final questionnaire demonstrated strong internal reliability, with Cronbach's alpha coefficients above 0.89 in all sections.

2.5 Data collection

The survey remained open for three months and was distributed electronically. Participation was voluntary, with no monetary or academic incentives provided. To improve response rates, reminder emails and messages were sent periodically. Participant anonymity and data confidentiality were rigorously maintained throughout the process.

2.6 Data analysis

Descriptive statistics were applied to outline demographic characteristics and key trends in responses. To assess differences in categorical variables between countries, chi-square tests were conducted. Additionally, logistic regression analysis was performed to identify factors associated with AI use in clinical practice, with independent variables including country, knowledge level, attitude scores, years of experience, and professional designation. A ρ-value below 0.05 was considered statistically significant. All statistical analyses were conducted using SPSS version 21 (IBM Corp., Armonk, NY, USA).

3. Results

A total of 655 pediatric dentists from SA (n = 231), MY (n = 181), and PK (n = 243) participated in this study. The findings are presented in alignment with the study objectives.

3.1 Demographic characteristics

Across the three countries, there was a predominance of male participants. In SA, 60.6% (n = 140) of respondents were male, compared to 39.4% (n = 91) female. Similarly, in MY, 65.2% (n = 118) were male and 34.8% (n = 63) were female. In PK, the gender distribution was slightly more balanced, with 55.1% (n = 134) male and 44.9% (n = 109) female as shown in Fig. 1. The total participant distribution was relatively even across the countries, with slightly more representation from PK (37.1%), followed by SA (35.2%) and MY (27.6%).

Most of the individuals responding in SA were residents accounting for 34.20% (n = 79) trailed by senior consultants as shown in Fig. 2A. On contrast to that more of the senior consultants responded from MY 39.80% (n = 72) and from PK approximately 30.50% (n = 74) as shown in Fig. 2B,C.

Most individuals responding from SA and MY mostly had an experience ranging from 6–10 years as shown in Fig. 3A,B. Whereas a higher percentage of individuals was observed to have 11 years and above experience those responding from PK (34.6%) (Fig. 3C).

3.2 Knowledge of AI applications in prosthodontics and oral medicine

Overall, a substantial proportion of participants reported being aware of artificial intelligence (AI) applications in prosthodontics and oral medicine. Awareness was highest among MY respondents, where 95.6% indicated familiarity with AI applications (Fig. 4A). This was followed by 85.6% of participants from PK and 78.8% from SA. Conversely, unawareness of AI was more common in SA (21.2%) compared to PK (14.4%) and MY (4.4%) as shown in Fig. 4A.

As shown in Fig. 4B, most of the respondents strongly agreed/agreed that use of AI can have a promising scope in pediatric prosthodontic treatment with highest from PK 97.1% trailed by MY (96.7%) and SA (92.7%). Nearly 50% of the respondents are confident that AI can assist in early diagnosis of pathological conditions among the pediatric patients (Fig. 4C). A greater proportion of respondents were familiar with at least one AI software (Diagnocat, Pearl, or Overjet) making an average count of 54.7% respondents from the three countries (Fig. 4D).

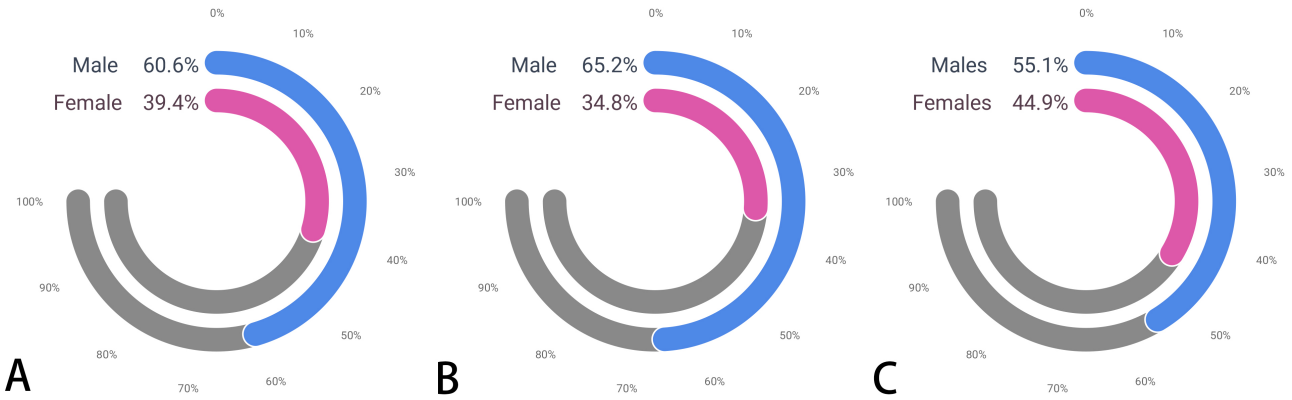

FIGURE 1. Gender distribution of the respondents across different countries (A) SA; (B) MY; & (C) PK.

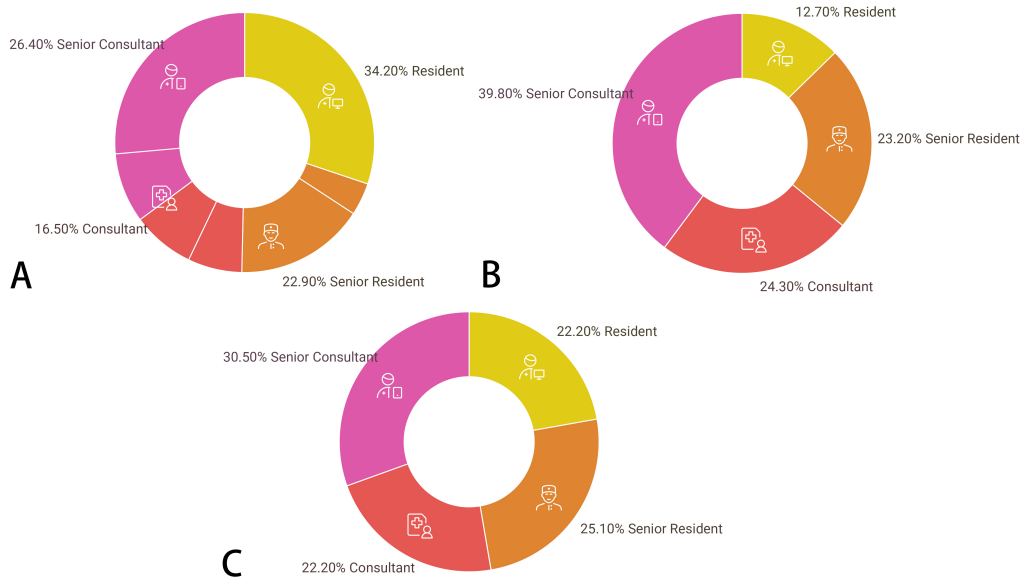

FIGURE 2. Designation of the respondents from various countries (A) SA; (B) MY; & (C) PK.

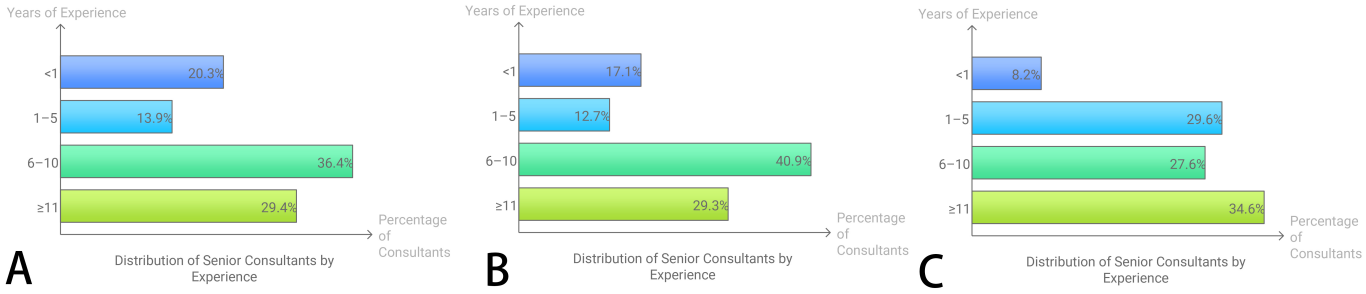

FIGURE 3. Distribution of respondents from various countries based on the years of experience (A) SA; (B) MY; & (C) PK.

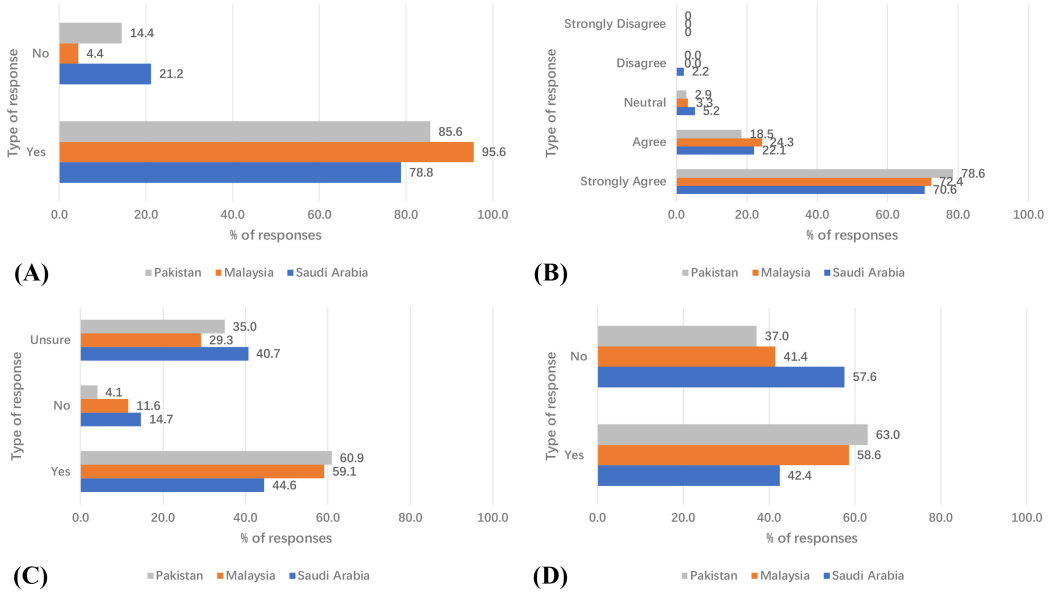

FIGURE 4. Level of knowledge regarding the use of AI in pediatric prosthodontics among respondents from various countries. (A) Respondent awareness of AI applications in pediatric prosthodontics, including its potential uses in diagnosis, treatment planning, and prostheses design. (B) Perceived potential of AI to improve accuracy in designing pediatric dental prostheses, as reported by respondents. (C) Respondent opinions on whether AI can assist in the early diagnosis of oral pathologies in children. (D) Familiarity levels among respondents with AI-based dental software tools (Diagnocat, Pearl, or Overjet) used in pediatric dentistry.

3.3 Attitudes towards AI integration in pediatric dental practice

Across all three countries, pediatric dentists demonstrated overwhelmingly positive attitudes towards the integration of AI into dental practice. In PK, 97.1% either strongly agreed or agreed that AI could improve treatment outcomes in pediatric dentistry. Similar positive sentiment was noted in MY (96.7%) and SA (92.7%). Neutral responses were minimal, reported by 5.2% of Saudi participants, 3.3% of MYs, and 2.9% of PKs. The proportion of respondents expressing disagreement or strong disagreement was negligible in all three countries (SA: 2.2%; MY and PK: 0%) as shown in Fig. 5A. On relation to confidence in improving the treatment outcomes while using AI technology, 49.53% individuals across three countries strongly in new AI advancement (Fig. 5B). While a higher percentage of respondents still disagree from PK (42.4%) that AI can have a positive role in pediatric dental practices.

AI is an evolving technology, therefore a higher number of individuals more than 90% across three countries consider trusting an AI-based diagnosis without human verification unacceptable (Fig. 5C). Though the respondents strongly believe AI training be mandatory in pediatric dentistry curricula during their undergraduate studies (Fig. 5D). Nealy, 50% of the respondents across three countries consider AI can increase treatment costs for pediatric patients (Fig. 5E).

3.4 Current practices and perceived barriers to AI adoption

Despite high levels of awareness and positive attitudes, the actual usage of AI tools in pediatric dental practice remained limited. AI tool integration was most prevalent in MY, with 37.6% of respondents reporting practical experience. In SA, 16.5% of participants had used AI tools, while usage was notably lower in PK (9.9%). The most perceived barriers across all regions (although not explicitly quantified here) included high costs, lack of training opportunities, concerns about reliability, and resistance to change, underscoring significant hurdles to wider adoption (Fig. 6A).

As shown in Fig. 6B, respondents from SA (44.6%) and MY (55.8%) consider lack of training as the biggest barrier for AI adaptation. While in PK, 32.1% of the individuals consider resistance to change as a major factor in AI adaptation. On average, higher than 95%, respondents from three countries prefer to adapt AI in their routine clinical practice if it is affordable and easy to use (Fig. 6C). Most of the respondents consider AI integration to be mainly needed in Prosthodontics (Pros) trailed by Preventive care (PC) (Fig. 6D).

3.5 Statistical analysis

Chi-square tests of association were conducted to examine the bivariate relationships between AI tool integration and key predictors. The analysis revealed no statistically significant association between knowledge of AI and practice of AI tool integration ($\chi^2 = 0.61$, $\rho = 0.44$). Similarly, no significant association was found between positive attitude towards AI and its usage in practice ($\chi^2 = 0.46$, $\rho = 0.50$). However, a significant association was observed between country of practice and AI tool integration ($\chi^2 = 52.59$, $\rho < 0.001$), indicating substantial regional variation in adoption rates.

To further explore these relationships while adjusting for potential confounding factors, a binary logistic regression was conducted. The dependent variable was AI tool integration (yes/no), with predictors including knowledge, attitude, and country of practice (MY as reference category). The model was statistically significant ($\chi^2 = 50.72$, $\rho < 0.001$), with a pseudo R^2 of 0.078, indicating modest explanatory power.

Consistent with the chi-square analysis, the country of practice emerged as a significant predictor. Compared to Malaysian participants, dentists from PK had significantly lower odds of AI tool integration ($\beta = -1.71$, $\rho < 0.001$), as did those from SA ($\beta = -1.11$, $\rho < 0.001$). Neither knowledge ($\beta = -0.04$, $p = 0.91$) nor positive attitude ($\beta = 0.48$, $\rho = 0.40$) independently predicted AI tool integration after adjusting for country as shown in Fig. 7.

4. Discussion

4.1 Key findings

This study provides a comprehensive evaluation of dental professionals' awareness, perceptions, and adoption of AI in pediatric prosthodontics and oral medicine across PK, MY, and SA, revealing noteworthy insights into the existing landscape and potential trajectory of AI integration in this specialized field. The findings indicate a generally high level of awareness regarding AI applications among pediatric dentists, yet actual clinical implementation lags significantly, highlighting a gap between theoretical knowledge and practical application [8]. This discrepancy underscores the necessity for targeted interventions to facilitate the translation of awareness into tangible clinical practice, particularly in regions where adoption rates are relatively low [9]. The study revealed that while knowledge and positive attitudes towards AI are widespread, they do not necessarily translate into active AI tool integration [9].

The substantial regional variation in AI adoption rates suggests that factors beyond individual knowledge and attitudes play a crucial role. The logistic regression analysis further emphasized the significance of regional context, with country of practice emerging as a robust predictor of AI tool integration even after controlling for knowledge and attitudes. This finding underscores the importance of infrastructural and institutional support in facilitating AI adoption [10]. The study also elucidated several key barriers hindering AI integration, including high costs, lack of training opportunities, concerns about reliability, and resistance to change. The identification of these barriers highlights the need for multifaceted strategies to overcome these obstacles, including financial incentives, continuing education programs, and robust validation studies to establish the reliability and efficacy of AI tools in pediatric dental settings.

Furthermore, addressing ethical considerations is crucial to ensure responsible and equitable AI integration [7]. The study's limitations include its cross-sectional design, which precludes causal inferences. Additionally, the reliance on self-reported data may be subject to biases, such as social desirability bias, which could influence responses regarding

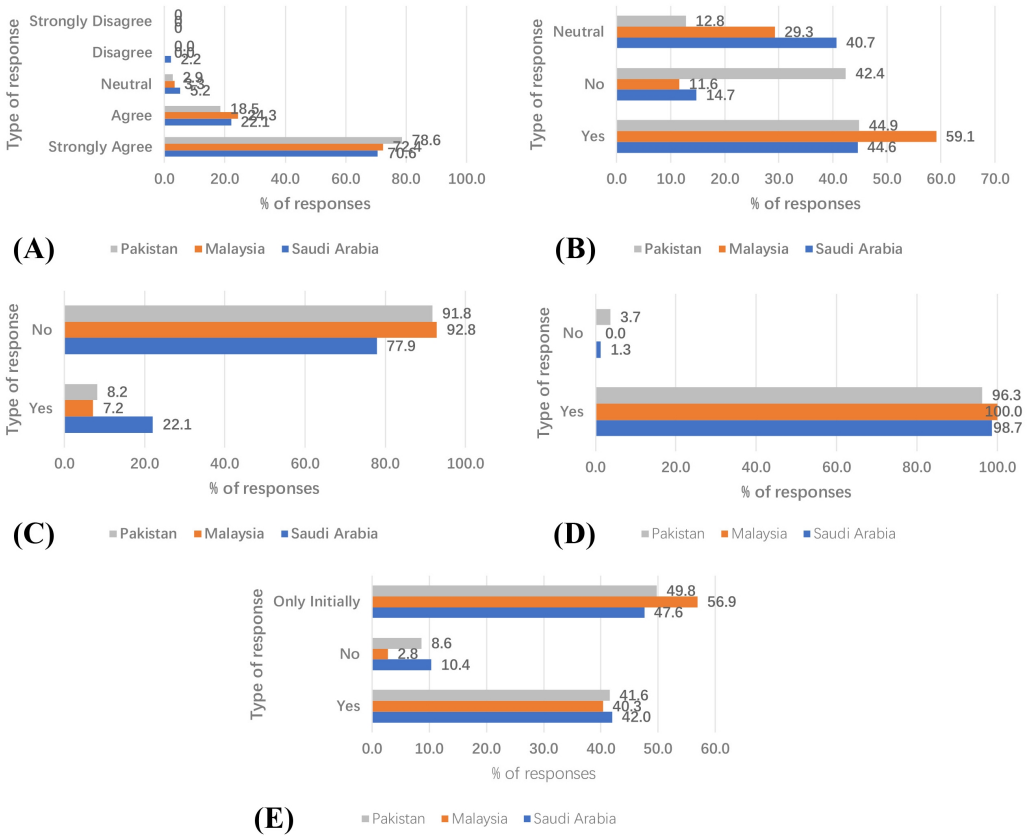

FIGURE 5. Attitudes of dental professionals from various countries toward the integration of AI in pediatric dental practice. (A) Perceptions on whether AI adoption could enhance treatment outcomes in pediatric dentistry, including improvements in accuracy, efficiency, and patient care. (B) Concerns among respondents regarding the potential for AI to replace human clinicians in pediatric dentistry, assessing fears about job displacement and loss of clinical autonomy. (C) Willingness to trust AI-generated diagnoses without human oversight, evaluating confidence in AI's reliability and safety for pediatric patients. (D) Opinions on whether AI education should be a compulsory component of pediatric dentistry training programs, reflecting the perceived importance of technological competency in future practice. (E) Anticipated impact of AI integration on treatment costs for pediatric patients, exploring whether respondents believe AI will increase affordability or introduce financial barriers.

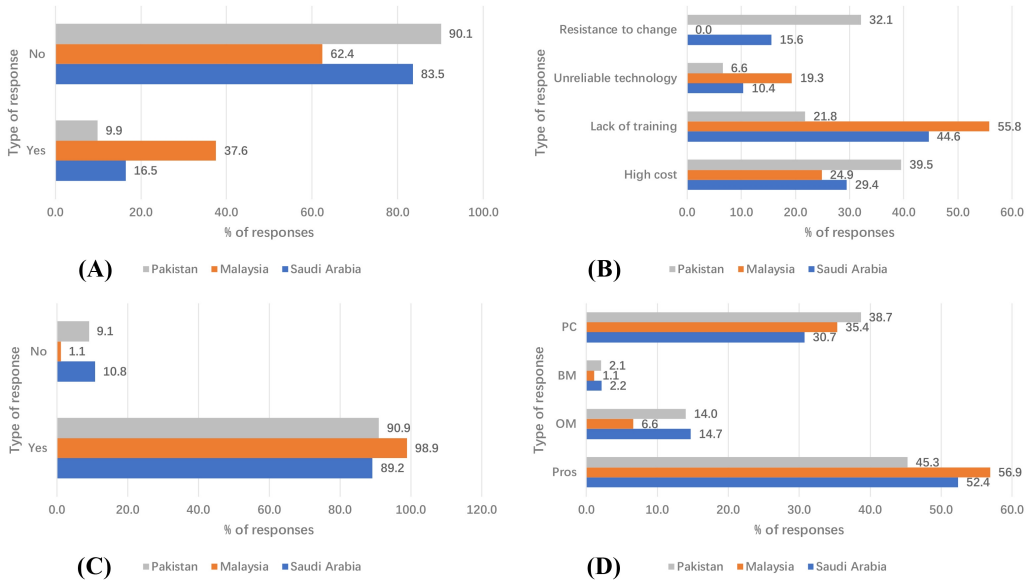

FIGURE 6. Current practices and perceived barriers to AI adoption. (A) Have you used AI tools in pediatric dental practice? (B) What is the biggest barrier to AI adoption? (C) Would you adopt AI if it were affordable and easy to use? (D) Which area needs AI integration the most? Pros: prosthodontics; OM: oral medicine; BM: behavior management; PC: preventive care.

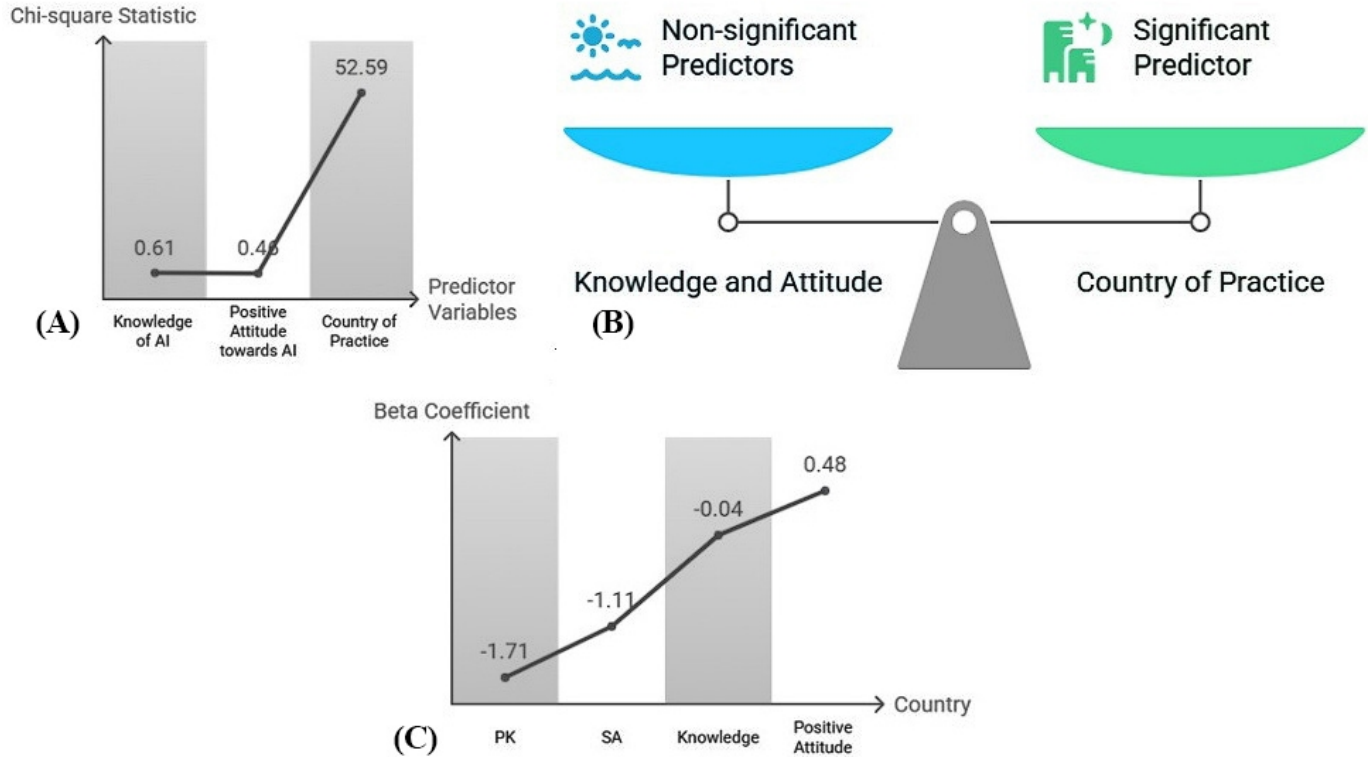

FIGURE 7. Statistical analysis of predictors influencing AI tool integration in pediatric dentistry. (A) Chi-square tests assessing bivariate relationships. (B) Binary logistic regression model. (C) Non-significance of knowledge ($\beta = -0.04$, "ρ" = 0.91) and attitude ($\beta = 0.48$, "ρ" = 0.40) as independent predictors after adjustment, reinforcing country-specific adoption trends. AI: artificial intelligence; PK: Pakistan; SA: Saudi Arabia.

AI awareness, attitudes, and usage. Future research should employ longitudinal designs to examine the long-term impact of AI integration on clinical outcomes and patient experiences, as well as explore the interplay between individual, organizational, and contextual factors in shaping AI adoption in pediatric dentistry. Long-term studies evaluating the clinical impact of AI algorithms are needed to assess their effectiveness, safety, and cost-effectiveness [5]. Moreover, further studies should examine public attitudes towards AI in pediatric healthcare [11]. Addressing data quality and algorithm bias is crucial for ensuring equitable AI applications in pediatric care [12]. As healthcare increasingly integrates AI, it is essential for pediatricians to be educated on its applications, benefits, and limitations [13]. The heterogeneity in AI applications and datasets necessitates careful evaluation and validation in real-world settings [14].

Healthcare leaders must play a crucial role in overcoming barriers by addressing inexperience and skepticism, aligning implementation with digital maturity, and refining AI applications [15]. The "black box" nature of AI significantly impedes its social acceptance, and it is unclear whether patients will accept diagnoses from computers rather than clinicians, especially if cost and time savings appear to compromise quality [16]. AI systems require substantial time for training and early-stage utilization, which may deter staff from embracing the technology, especially given the tedious and time-consuming tasks such as labeling raw data [16]. The emphasis should be on designing solutions that are clear and usable for healthcare professionals within clinical settings [17]. Successfully integrating AI into healthcare requires effective and efficient utilization by clinicians, who may perceive AI as complex and demanding of extensive training [18]. The implementation of AI in healthcare requires that ethical and legal considerations be at the forefront of decision-making, particularly regarding patient data privacy and algorithmic transparency [19]. Ultimately, the safe and timely translation of AI research into clinically validated and appropriately regulated systems is crucial for benefiting everyone [20].

4.2 Barriers in use of AI

Addressing systemic barriers through targeted strategies can promote the successful integration of AI into medical practice [21]. AI has the potential to revolutionize cancer care by improving diagnosis, treatment, and patient outcomes, but its successful integration requires collaborative and multidisciplinary efforts [22]. Successfully integrating AI into healthcare requires effective and efficient utilization by clinicians, who may perceive AI as complex and demanding of extensive training [23]. Newly introduced changes and their implementation are being faced with mixed attitudes and feelings by healthcare professionals because accepting change is not a simple process [24]. Change management, engagement, and workflow strategies should be used for AI implementation, also leadership strategies, collaboration and contracts among key stakeholders, legal strategies surrounding clinicians' liability, solutions to ethical dilemmas, and infrastructure for efficient integration of AI in workflows should also be considered [25].

The conservatism of existing medical systems poses signifi-

cant obstacles to the adoption of AI in healthcare, as healthcare systems tend to favor established practices over new technologies, potentially slowing down AI adoption due to skepticism about its benefits and concerns about disrupting current workflows [21]. Smaller medical institutions may lack the resources needed to adopt advanced AI technologies, and the dominance of large corporations in AI could limit its widespread use, thereby perpetuating healthcare inequalities [26]. The "black box" nature of AI significantly impedes its social acceptance, and it is unclear whether patients will accept diagnoses from computers rather than clinicians, especially if cost and time savings appear to compromise quality [27, 28]. To gain societal trust, AI systems must provide reliable and transparent decision-making processes. Ethical and regulatory challenges surrounding AI technologies in healthcare necessitate a robust governance framework to foster acceptance and successful implementation [29]. A comprehensive strategy involving policymakers, developers, healthcare providers, and patients is essential to address the ethical and legal issues associated with AI in healthcare [30].

The advent of AI in healthcare signifies a transformative era with the potential to enhance patient care and optimize therapeutic outcomes [21]. However, the integration of AI into clinical settings presents significant ethical, legal, and regulatory challenges that must be addressed to ensure responsible and equitable implementation [29, 31]. The integration of AI in healthcare, while promising, brings about substantial challenges related to ethics, legality, and regulations [29]. It is crucial to address challenges such as data protection, privacy, and the roles of both physicians and machines in patient care to ensure the ethical integration of AI [27]. The foremost ethical considerations in AI revolve around patient privacy, algorithm transparency, and data quality [30]. The application of AI in healthcare raises concerns regarding data privacy and the potential for algorithmic bias, emphasizing the need for careful data management and robust regulatory frameworks [32]. It is imperative to establish detailed regulations and frameworks for the ethical deployment of AI in healthcare to ensure patient safety and data security [33].

The successful integration of AI into healthcare requires a multifaceted approach that balances technological innovation with ethical oversight and regulatory compliance [34, 35]. The successful integration of AI in healthcare calls for a conscientious approach, guided by ethical integrity, inclusivity, and respect for the patient-caregiver relationship [36]. The integration of artificial intelligence into healthcare research marks a pivotal shift towards groundbreaking advancements in diagnostics, treatment, and patient care management [37]. The use of AI technologies should be grounded in ethical principles, ensuring that fairness, transparency, and accountability are integral to their application in healthcare. To maximize AI's potential in healthcare, interdisciplinary collaboration, ethical guidelines, and the protection of patient rights are essential [38]. This includes the need for strategies that promote change management, engagement, and collaboration among stakeholders, as well as addressing legal considerations, ethical dilemmas, and the development of efficient AI integration workflows.

The observed regional variation in AI adoption—with Malaysia demonstrating significantly higher usage rates compared to Saudi Arabia and Pakistan—warrants further exploration of underlying structural and cultural factors. In Malaysia, robust digital infrastructure, government-led initiatives promoting healthcare technology (*e.g.*, the MyHealth Digital Transformation Blueprint), and higher institutional support for continuing education may contribute to greater AI integration. Conversely, in Pakistan, economic constraints, limited access to advanced dental technologies in public healthcare settings, and fragmented training opportunities likely hinder adoption. In Saudi Arabia, while Vision 2030 prioritizes technological innovation, practical barriers such as reimbursement challenges for AI tools and variability in training across institutions may slow implementation. Cultural attitudes toward technology adoption, including trust in AI-driven diagnoses and clinician autonomy, could further explain these disparities. Future research should investigate these contextual factors through qualitative methods to inform region-specific strategies for AI integration.

A key limitation of this study is its reliance on purposive sampling, which, while practical for capturing targeted insights, may not fully represent the diversity of pediatric dental professionals in each region. For instance, practitioners affiliated with academic institutions or urban centers may have greater exposure to AI technologies than those in rural or private practice settings. This potential bias underscores the need for caution when extrapolating results to all dental professionals. Future studies could mitigate this limitation by incorporating stratified random sampling to enhance representativeness.

5. Conclusions

The study highlights a strong awareness and positive attitude toward AI among pediatric dentists in Saudi Arabia, Malaysia, and Pakistan, yet reveals a significant gap in its clinical adoption. Key barriers such as high costs, limited training, and ethical concerns must be addressed to facilitate AI integration into pediatric dental care. Tailored strategies, including policy reforms, educational initiatives, and affordable AI solutions, are essential to bridge this gap. By fostering collaboration among stakeholders and ensuring ethical oversight, AI can enhance precision, efficiency, and patient-centered care in pediatric dentistry, paving the way for a transformative future in the field. Integrating AI technologies in pediatric prosthodontics and oral medicine carries significant promise but also presents complex ethical and practical challenges. The primary challenges include issues related to inaccurate data annotation, limited capability for fine-grained feature expression, a lack of universally applicable models, potential biases in learning algorithms, and legal risks pertaining to medical malpractice and data privacy breaches. Addressing these multifaceted issues proactively is crucial to harness the potential of AI while upholding ethical standards and ensuring patient well-being in pediatric dental care.

ABBREVIATIONS

AI, artificial intelligence; SA, Saudi Arabia; MY, Malaysia; PK, Pakistan; Pros, prosthodontics; OM, oral medicine; BM, behavior management; PC, preventive care.

AVAILABILITY OF DATA AND MATERIALS

Detailed data is available in the materials and methods section.

AUTHOR CONTRIBUTIONS

ZQ, MGA, NAS and CS—designed the research study. ZQ, RNR, ATI, NMAZ and SAY—performed the research. ZQ and LAA—provided help and advice on improving the sample size. NAS, ZMA, MAMK and CS—analyzed the data. ZQ and CS—wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted of approval from the Institutional Review Board Committee of Riyadh Elm University, Riyadh, Saudi Arabia (No. RP/2025/578). All the participants signed the consent form.

ACKNOWLEDGMENT

Administrative and technical support was provided by Riyadh Elm University, Riyadh, Saudi Arabia.

FUNDING

This research was funded by Riyadh Elm University (No. RP/2025/578), Riyadh, Saudi Arabia.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Fawaz P, El Sayegh P, Vande Vannet B. Artificial intelligence in revolutionizing orthodontic practice. World Journal of Methodology. 2025; 15: 100598.

[2] Karnik AP, Chhajer H, Venkatesh SB. Transforming prosthodontics and oral implantology using robotics and artificial intelligence. Frontiers in Oral Health. 2024; 5: 1442100.

[3] Babu A, Andrew Onesimu J, Martin Sagayam K. Artificial intelligence in dentistry: concepts, applications and research challenges. E3S Web of Conferences. 2021; 297: 01074.

[4] Shan T, Tay FR, Gu L. Application of artificial intelligence in dentistry. Journal of Dental Research. 2020; 100: 232–244.

[5] Dhopte A, Bagde H. Smart smile: revolutionizing dentistry with artificial intelligence. Cureus. 2023; 15: e41227.

[6] Sharma S, Kumari P, Sabira K, Parihar AS, Rani PD, Roy A, *et al*. Revolutionizing dentistry: the applications of artificial intelligence in dental health care. Journal of Pharmacy and Bioallied Sciences. 2024; 16: S1910–S1912.

[7] Schwendicke F, Samek W, Krois J. Artificial intelligence in dentistry: chances and challenges. Journal of Dental Research. 2020; 99: 769–774.

[8] Singh N, Pandey A, Tikku AP, Verma P, Singh BP. Attitude, perception and barriers of dental professionals towards artificial intelligence. Journal of Oral Biology and Craniofacial Research. 2023; 13: 584–588.

[9] Hamd ZY, Elshami W, Al Kawas S, Aljuaid H, Abuzaid MM. A closer look at the current knowledge and prospects of artificial intelligence integration in dentistry practice: a cross-sectional study. Heliyon. 2023; 9: e17089.

[10] Aboalshamat K, Alhuzali R, Alalyani A, Alsharif S, Qadhi H, Almatrafi R, *et al*. Medical and dental professionals readiness for artificial intelligence for Saudi Arabia vision 2030. International Journal of Pharmaceutical Research and Allied Sciences. 2022; 11: 52–59.

[11] Chew HSJ, Achananuparp P. Perceptions and needs of artificial intelligence in health care to increase adoption: scoping review. Journal of Medical Internet Research. 2022; 24: e32939.

[12] Wu C, Xu H, Bai D, Chen X, Gao J, Jiang X. Public perceptions on the application of artificial intelligence in healthcare: a qualitative meta-synthesis. BMJ Open. 2023; 13: e066322.

[13] Bhargava H, Salomon C, Suresh S, Chang A, Kilian R, van Stijn D, *et al.* Promises, pitfalls, and clinical applications of artificial intelligence in pediatrics. Journal of Medical Internet Research. 2024; 26: e49022.

[14] Reinhart L, Bischops AC, Kerth JL, Hagemeister M, Heinrichs B, Eickhoff SB, *et al*. Artificial intelligence in child development monitoring: a systematic review on usage, outcomes and acceptance. Intelligence-Based Medicine. 2024; 9: 100134.

[15] Siira E, Tyskbo D, Nygren J. Healthcare leaders' experiences of implementing artificial intelligence for medical history-taking and triage in Swedish primary care: an interview study. BMC Primary Care. 2024; 25: 268.

[16] Ahmed MI, Spooner B, Isherwood J, Lane M, Orrock E, Dennison A. A systematic review of the barriers to the implementation of artificial intelligence in healthcare. Cureus. 2023; 15: e46454.

[17] Zhang J, Zhang ZM. Ethics and governance of trustworthy medical artificial intelligence. BMC Medical Informatics and Decision Making. 2023; 23: 7.

[18] Shamszare H, Choudhury A. Clinicians' perceptions of artificial intelligence: focus on workload, risk, trust, clinical decision making, and clinical integration. Healthcare. 2023; 11: 2308.

[19] Abukhadijah HJ, Nashwan AJ. Transforming hospital quality improvement through harnessing the power of artificial intelligence. Global Journal on Quality and Safety in Healthcare. 2024; 7: 132–139.

[20] Kelly CJ, Karthikesalingam A, Suleyman M, Corrado G, King D. Key challenges for delivering clinical impact with artificial intelligence. BMC Medicine. 2019; 17: 1–9.

[21] Li YH, Li YL, Wei MY, Li GY. Innovation and challenges of artificial intelligence technology in personalized healthcare. Scientific Reports. 2024; 14: 18994.

[22] Garcia-Saiso S, Marti M, Pesce K, Luciani S, Mujica O, Hennis A, *et al*. Artificial intelligence as a potential catalyst to a more equitable cancer care. JMIR Cancer. 2024; 10: e57276.

[23] Pagallo U, O'Sullivan S, Nevejans N, Holzinger A, Friebe M, Jeanquartier F, *et al*. The underuse of AI in the health sector: opportunity costs, success stories, risks and recommendations. Health and Technology. 2024; 14: 1–14.

[24] Lambert SI, Madi M, Sopka S, Lenes A, Stange H, Buszello CP, *et al.* An integrative review on the acceptance of artificial intelligence among healthcare professionals in hospitals. npj Digital Medicine. 2023; 6: 111.

[25] Nair M, Svedberg P, Larsson I, Nygren JM. A comprehensive overview of barriers and strategies for AI implementation in healthcare: mixed-method design. PLOS ONE. 2024; 19: e0305949.

[26] Marko JGO, Neagu CD, Anand PB. Examining inclusivity: the use of AI and diverse populations in health and social care: a systematic review. BMC Medical Informatics and Decision Making. 2025; 25: 57.

[27] Akinrinmade AO, Adebile TM, Ezuma-Ebong C, Bolaji K, Ajufo A, Adigun AO, *et al*. Artificial intelligence in healthcare: perception and reality. Cureus. 2023; 15: e45594.

[28] Bajwa J, Munir U, Nori A, Williams B. Artificial intelligence in healthcare: transforming the practice of medicine. Future Healthcare Journal. 2021; 8: e188–e194.

[29] Mennella C, Maniscalco U, De Pietro G, Esposito M. Ethical and regulatory challenges of AI technologies in healthcare: a narrative review. Heliyon. 2024; 10: e26297.
[30] Jeyaraman M, Balaji S, Jeyaraman N, Yadav S. Unraveling the ethical enigma: artificial intelligence in healthcare. Cureus. 2023; 15: e43262.
[31] Reddy S, Allan S, Coghlan S, Cooper P. A governance model for the application of AI in health care. Journal of the American Medical Informatics Association. 2020; 27: 491–497.
[32] Farhud DD, Zokaei S. Ethical issues of artificial intelligence in medicine and healthcare. Iranian Journal of Public Health. 2021; 50: i–v.
[33] Chen C, Chen Z, Luo W, Xu Y, Yang S, Yang G, *et al*. Ethical perspective on AI hazards to humans: a review. Medicine. 2023; 102: e36163.
[34] Al Kuwaiti A, Nazer K, Al-Reedy A, Al-Shehri S, Al-Muhanna A, Subbarayalu AV, *et al*. A review of the role of artificial intelligence in healthcare. Journal of Personalized Medicine. 2023; 13: 951.
[35] He J, Baxter SL, Xu J, Xu J, Zhou X, Zhang K. The practical implementation of artificial intelligence technologies in medicine. Nature Medicine. 2019; 25: 30–36.
[36] Shuaib A. Transforming healthcare with AI: promises, pitfalls, and pathways forward. International Journal of General Medicine. 2024; 17: 1765–1771.
[37] Abujaber AA, Nashwan AJ. Ethical framework for artificial intelligence in healthcare research: a path to integrity. World Journal of Methodology. 2024; 14: 94071.
[38] Yelne S, Chaudhary M, Dod K, Sayyad A, Sharma R. Harnessing the power of AI: a comprehensive review of its impact and challenges in nursing science and healthcare. Cureus. 2023; 15: e49252.

How to cite this article: Nishath Abdul Sayed, Zeeshan Qamar, Auj Tameer Islam, Nada Mustafa Abu-Zayed, Sara Ayman Yousef, Manar Ghazi Altoukhi, Leena Abdullah AlAmri, Zahra Muneer AlSaffar, Cristalle Soman, R Naveen Reddy, Mohammed Ahmed Mohammed Khder. AI integration in pediatric dentistry: perspectives from Saudi Arabia, Malaysia, and Pakistan. Journal of Clinical Pediatric Dentistry. 2026; 50(3): 72-81. doi: 10.22514/jocpd.2026.062.