

## ORIGINAL RESEARCH

# Knowledge, attitude and practice (KAP) of dentists regarding the use of digital workflow in pedo-prosthetic rehabilitation: a comparative study across three countries

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## Abstract

**Background:** The integration of digital workflows in paediatric prosthetic dentistry has the potential to enhance treatment accuracy, efficiency and patient experience. However, limited research has explored the knowledge, attitudes, and practices of paediatric dentists toward digital prosthetics, particularly in Saudi Arabia, Malaysia and Pakistan. This study aimed to evaluate the awareness, acceptance, and barriers to adopting digital workflows such as computer-aided design (CAD)/computer-aided manufacturing (CAM), intraoral scanning, and three-dimensional (3D) printing in paediatric prosthetic rehabilitation. **Methods:** A cross-sectional survey was conducted among paediatric dentists in Saudi Arabia, Malaysia and Pakistan. Data was collected using a structured questionnaire disseminated via email, Telegram and WhatsApp. The questionnaire assessed knowledge, attitudes, and practices using Likert-scale responses. Statistical analysis was performed employing a chi-square test to compare categorical variables and Spearman's correlation to evaluate relationships between knowledge, attitudes and practices. **Results:** Findings revealed that awareness of digital prosthetic solutions was highest in Saudi Arabia (66.4% strongly agreed) and Pakistan (61.4% strongly agreed), while Malaysia demonstrated slightly lower familiarity (50.7% strongly agreed). Despite a strong positive attitude toward digital prosthetics, formal training in digital workflows was limited, with only 16.8% of respondents in Saudi Arabia, 8% in Pakistan, and 16.7% in Malaysia receiving relevant training. Cost emerged as a primary barrier to adoption, with 69% of Saudi dentists, 54.5% of Pakistani dentists, and 47.2% of Malaysian dentists identifying it as a concern. Statistical analysis indicated significant differences in knowledge levels among designations ( $p < 0.05$ ), but no significant correlations were found between awareness, attitudes and practices ( $p \geq 0.05$ ). **Conclusions:** The study highlights a promising outlook for digital prosthetics in paediatric dentistry, with strong acceptance but limited training and financial constraints hindering widespread adoption. Addressing these challenges through educational initiatives and cost-reduction strategies will be essential to enhancing integration and accessibility of digital workflows in paediatric prosthetic rehabilitation.

## Keywords

Digital workflows; Pediatric prosthetic dentistry; CAD/CAM technology; 3D printing in dentistry; Dentists' perceptions

## 1. Introduction

The researchers have aimed to revolutionise paediatric prosthetic dentistry by exploring the knowledge, attitude, and practice of paediatric dentists and parents regarding the use of digital workflows like CAD/CAM, intraoral scanners and 3D printing [1]. These digital technologies offered numerous

benefits, including improved accuracy, efficiency and patient experience, enhancing the entire treatment process. Previous studies had highlighted these advantages, demonstrating how digital design and manufacturing from optical impressions enhanced both laboratory and clinical effectiveness [2–4]. However, the adoption of such advanced technologies in paediatric dentistry remained underexplored. Though parents play a cru-

cial role in decision-making for paediatric prosthetic treatment, their knowledge and attitude toward digital prosthetic solutions were not well understood [5]. Moreover, the barriers that hindered paediatric dentists from embracing digital workflows in their practice have needed to be assessed [6].

The digitalised scanners minimised human manipulation, reducing inaccuracies and fabrication time. Furthermore, digital techniques strengthened diagnostic visualisation, improved treatment predictability, and enhanced communication between patients, doctors and technicians [4].

Paediatric dentists' awareness, acceptance, and barriers to adopting digital workflows in prosthetic rehabilitation needed further assessment. The researchers aimed to address this gap by investigating the knowledge, attitude, and practice of paediatric dentists regarding digital workflows in paediatric prosthetic rehabilitation within the context of Saudi Arabia, Malaysia and Pakistan. Understanding the perspectives of paediatric dentists, the primary providers of these treatments, was crucial to identifying barriers and facilitators to integrating digital workflows in their clinical practice across these three countries. This research explored the specific challenges and opportunities presented by the varying healthcare systems and cultural contexts of Saudi Arabia, Malaysia and Pakistan. It provided valuable insights into the adoption and implementation of digital prosthetic solutions for children in these regions. It was hypothesised that the paediatric dentists in Saudi Arabia, Malaysia, and Pakistan have significant knowledge and a positive attitude toward digital workflows in paediatric prosthetic rehabilitation; however, its adoption is hindered by limited training and financial constraints.

## 2. Materials and methods

This study investigated the knowledge, attitude, and practice of paediatric dentists regarding digital workflows in paediatric prosthetic rehabilitation in Saudi Arabia, Malaysia and Pakistan. Ethical approval was obtained from Riyadh Elm University, Riyadh, Saudi Arabia (FRP/2025/571). The research team sent a close-ended questionnaire with Likert scale questions to the participants in November 2024 via Telegram, Facebook, LinkedIn and email, using Google Forms for data collection, targeting representative samples of paediatric dentists in these three countries. The sample size was calculated prior to the commencement of the study and was approximately 124 respondents required from each population.

To ensure relevant data, strict inclusion criteria were applied. Participants included professionals specialising in paediatric dentistry, provided they had graduated or completed board training from medical or dental schools in the selected countries. Practitioners with postgraduate qualifications from other countries, and individuals not practising were excluded. Potential biases, including selection bias, were mitigated by ensuring a balanced distribution across different demographic categories maintaining minimum 124, while response bias was addressed through anonymous data collection and a pretested questionnaire to enhance clarity and reliability. Additionally, measures were taken to account for avoiding non-responses and incomplete surveys, ensuring robust and generalizable findings.

The survey form included 18 closed-ended questions designed to evaluate three main aspects: awareness, behaviour, and perceptions related to paediatric dentists towards the use of digital workflow in paediatric prosthetic rehabilitation. Respondents participated voluntarily without any conflicts of interest. The questionnaire started with demographic information, including age, gender, designation and details regarding years of experience.

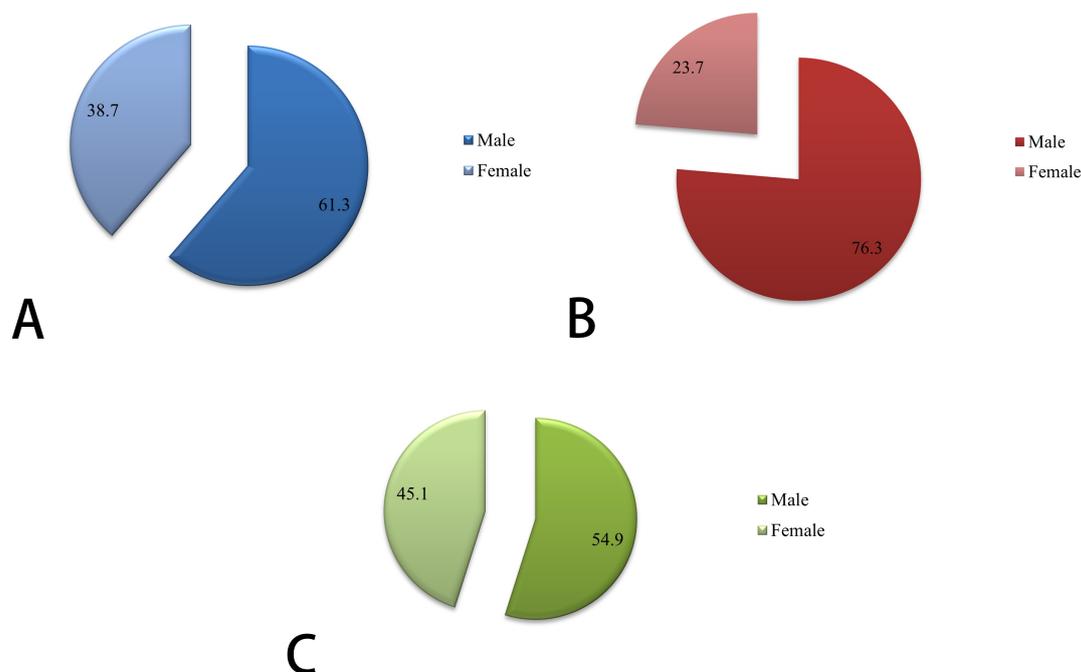
The gathered data were statistically analysed using SPSS version 21.0 (IBM, Chicago, IL, USA). Non-parametric chi-square tests compared variables such as age, clinical experience and designation. Additionally, Spearman's correlation coefficient test was used to determine statistical relationships between awareness, behaviour, and attitudes of paediatric dentists towards the use of digital workflow in paediatric prosthetic rehabilitation.

## 3. Results

The survey after the initial pilot was distributed to the paediatric practitioners who frequently assess the patients for prosthodontics therapy. On average, participants took approximately 7 minutes to complete the survey. Among the respondents, 534 (67.3%) were male and 260 (32.7%) were female, totalling 794 participants from three countries, as shown in Fig. 1. These practitioners, aged between 27 and 58 years, had completed postgraduate training at dental institutions in the respective countries, as detailed in Table 1 under the socio-demographic profiles of the respondents.

The practitioners' knowledge was assessed using six strongly disagree—strongly agree Likert scale questions, illustrated in Fig. 2. A majority of respondents in Saudi Arabia (66.4% strongly agree, 19.3% agree) and Pakistan (61.4% strongly agree, 25.5% agree) reported familiarity with digital prosthetic solutions like CAD/CAM and 3D printing. However, Malaysia showed a slightly lower level of familiarity, with 50.7% strongly agreeing and 27.8% agreeing (Fig. 2A). As shown in Fig. 2B, most respondents in Saudi Arabia (58% strongly agree, 29.6% agree) and Malaysia (56.3% strongly agree, 25% agree) believed that digital prosthetics offer better fit and accuracy compared to traditional methods. This perception was less prevalent in Pakistan, with 43.6% strongly agreeing and 27.9% agreeing.

Across all three countries, the level of formal training on digital prosthetic techniques in paediatric dentistry was relatively low. Only 16.8% of respondents in Saudi Arabia, 8% in Pakistan, and 16.7% in Malaysia reported having received such training (Fig. 2C). The vast majority of respondents, as shown in Fig. 2D, in Saudi Arabia (76.3% strongly agree, 20.4% agree) believed that digital workflows could reduce chairside time, thus simplifying treatment for young patients. This view was also prevalent in Pakistan (37.8% strongly agree, 29% agree) and Malaysia (43.8% strongly agree, 35.4% agree), although to a lesser extent. While a considerable proportion of respondents in Saudi Arabia (SA) (50.4% strongly agree, 16.1% agree) reported understanding the cost differences between traditional and digital solutions, this understanding was less common in Pakistan (PK) (41.8% strongly agree, 27.7% agree) and Malaysia (MY) (35.4%



**FIGURE 1. Gender of respondents from three different countries in percentages.** (A) Respondents from Saudi Arabia. (B) Respondents from Pakistan. (C) Respondents from Malaysia.

**TABLE 1. Socio-demographic data of the respondents from three countries.**

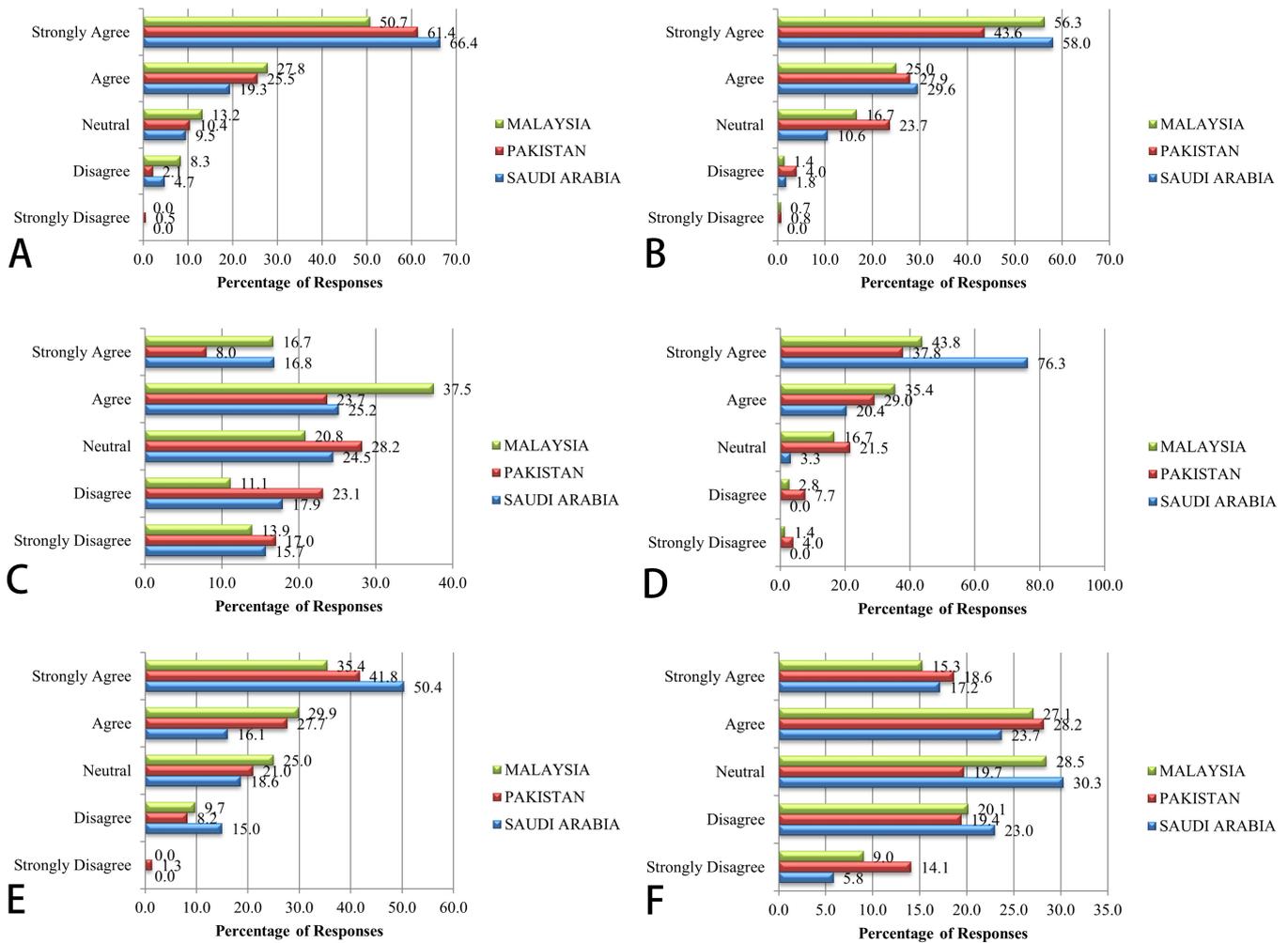
	Saudi Arabia n (%)	Pakistan n (%)	Malaysia n (%)
<b>Gender</b>			
Male	168 (61.3)	287 (76.3)	79 (54.9)
Female	106 (38.7)	89 (23.7)	65 (45.1)
<b>Designation</b>			
Resident	79 (28.8)	74 (19.7)	48 (33.3)
Senior Resident	54 (19.7)	82 (21.8)	43 (29.9)
Consultant	83 (30.3)	106 (28.2)	37 (25.7)
Senior Consultant	58 (21.2)	114 (30.3)	16 (11.1)
<b>Clinical experience in years</b>			
<1	58 (21.2)	21 (5.6)	10 (6.9)
1–5	59 (21.5)	92 (24.5)	63 (43.8)
6–10	73 (26.6)	79 (21.0)	28 (19.4)
≥11	84 (30.7)	187 (49.7)	43 (29.9)

strongly agree, 29.9% agree) (Fig. 2E).

Across all three countries, there was a limited understanding of the long-term success of digital prostheses in paediatric patients, as evidenced by the research literature. Only 17.2% of respondents in Saudi Arabia, 18.6% in Pakistan, and 15.3% in Malaysia strongly agreed that this long-term success is well-documented. A substantial portion of respondents in each country selected neutral (SA: 30.3%, PK: 19.7%, MY: 28.5%), indicating uncertainty regarding the available evidence (Fig. 2F).

The practitioners' approaches regarding the integration of digital prosthetic solutions in their practice are summarised in Fig. 3A–E for Saudi Arabia, Malaysia and Pakistan. There's

a strong positive attitude towards incorporating digital prosthetics routinely, with overwhelming agreement observed in Saudi Arabia (74.1% strongly agree, 23.7% agree) and Pakistan (65.2% strongly agree, 21.5% agree). Malaysia also shows a positive trend, though with slightly less enthusiasm (48.6% strongly agree, 31.3% agree). This suggests a general willingness to embrace digital workflows within the paediatric dentistry community (Fig. 3A). As shown in Fig. 3B, dentists believe that parents are generally receptive to digital prosthetic options for their children. Saudi Arabia (71.2% strongly agree, 22.6% agree) and Pakistan (61.4% strongly agree, 25% agree) show strong agreement, while Malaysia demonstrates a slightly more cautious outlook (31.9% strongly agree, 29.9%



**FIGURE 2. The figures display responses of pediatric dentists from different populations knowledge towards use of digital flow in pediatric dentistry.** (A) Q1: I am familiar with the concept of digital prosthetic solutions (e.g., CAD/CAM, 3D printing) for children. (B) Q2: Compared to traditional methods, digital prosthetics provide a better fit and accuracy for pediatric patients. (C) Q3: I have received formal training on digital prosthetic techniques in pediatric dentistry. (D) Q4: Digital workflows (scanners, software and milling) can reduce chairside time, making treatment easier for young patients. (E) Q5: I understand the cost differences between traditional and digital prosthetic solutions. (F) Q6: The long-term success of digital prostheses in pediatric patients is well-documented in research.

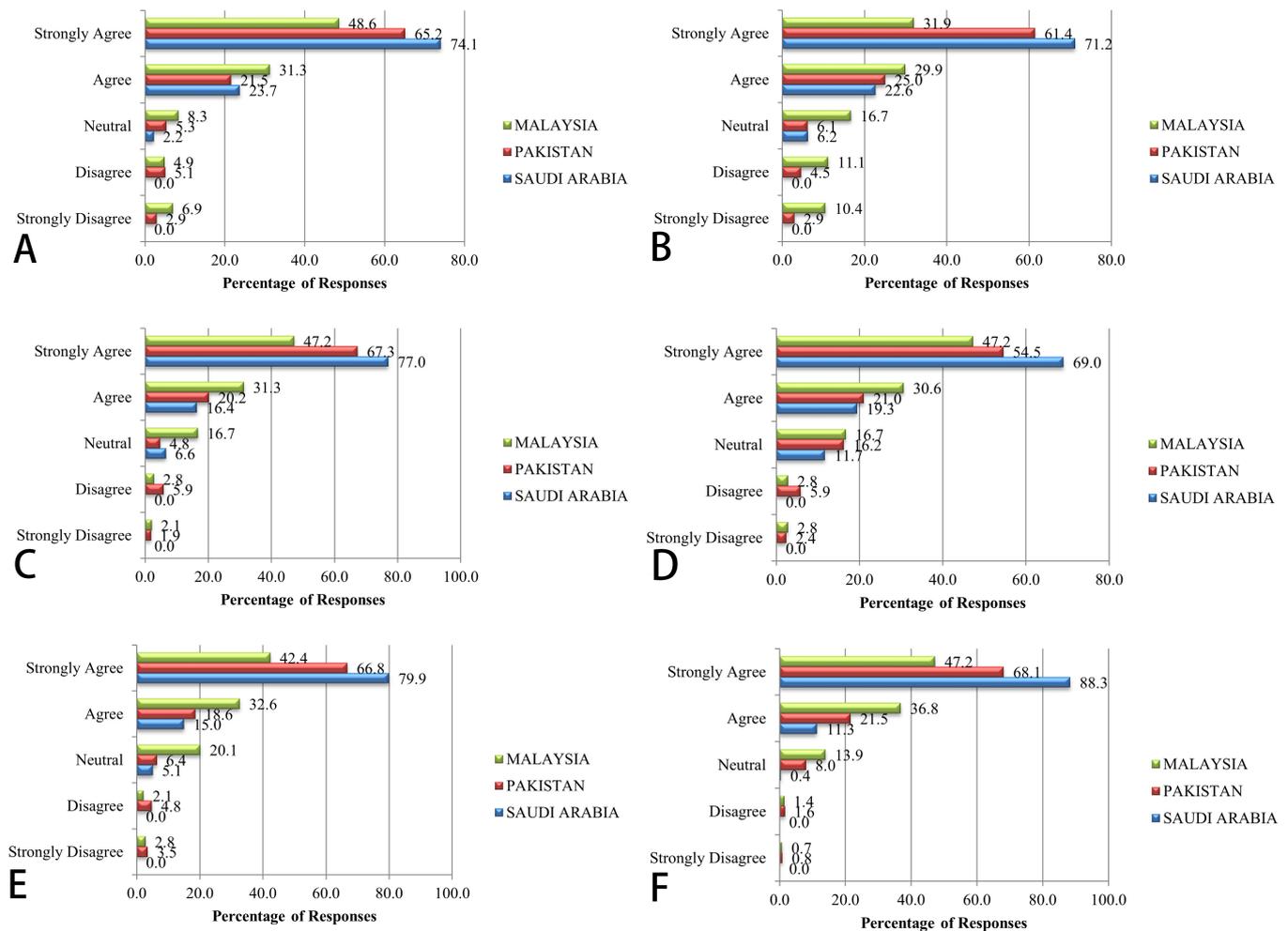
agree). This difference may reflect varying levels of parental awareness and exposure to digital dentistry in different regions.

However, as shown in Fig. 3C, there's a strong consensus that digital prosthetics improve the appearance and acceptance of dental prostheses in children. Saudi Arabia (77% strongly agree, 16.4% agree) and Pakistan (67.3% strongly agree, 20.2% agree) show particularly strong agreement. Malaysia also reflects this positive perception, with 47.2% strongly agreeing and 31.3% agreeing. But the cost remains a significant concern, with a majority of dentists in all three countries agreeing that it hinders wider adoption. Saudi Arabia (69% strongly agree, 19.3% agree), Pakistan (54.5% strongly agree, 21% agree) and Malaysia (47.2% strongly agree, 30.6% agree) all acknowledge the cost barrier. This suggests the need for innovative financing solutions or cost-reduction strategies to improve accessibility (Fig. 3D).

Dentists have high confidence in the durability and reliability of digital prosthetic solutions (Fig. 3E). Strong agreement is

observed in Saudi Arabia (79.9% strongly agree, 15% agree), Pakistan (66.8% strongly agree, 18.6% agree) and Malaysia (42.4% strongly agree, 32.6% agree). This positive perception of the technology's performance is crucial for its continued adoption. But there's overwhelming support for increased training opportunities in digital prosthetic techniques (Fig. 3F). Saudi Arabia (88.3% strongly agree, 11.3% agree), Pakistan (68.1% strongly agree, 21.5% agree) and Malaysia (47.2% strongly agree, 36.8% agree) all express a strong need for more training programmes and workshops. This highlights the importance of investing in professional development to equip paediatric dentists with the necessary skills.

Regarding practice, a significant portion of dentists in all three countries already utilise digital prosthetics, with 30.7% in Saudi Arabia, 43.4% in Pakistan, and 22.9% in Malaysia reported "always" using these solutions (Fig. 4A). Dentists frequently discuss digital options with parents. A large majority in Saudi Arabia (75.5%) and Pakistan (66.1%) do so "always".



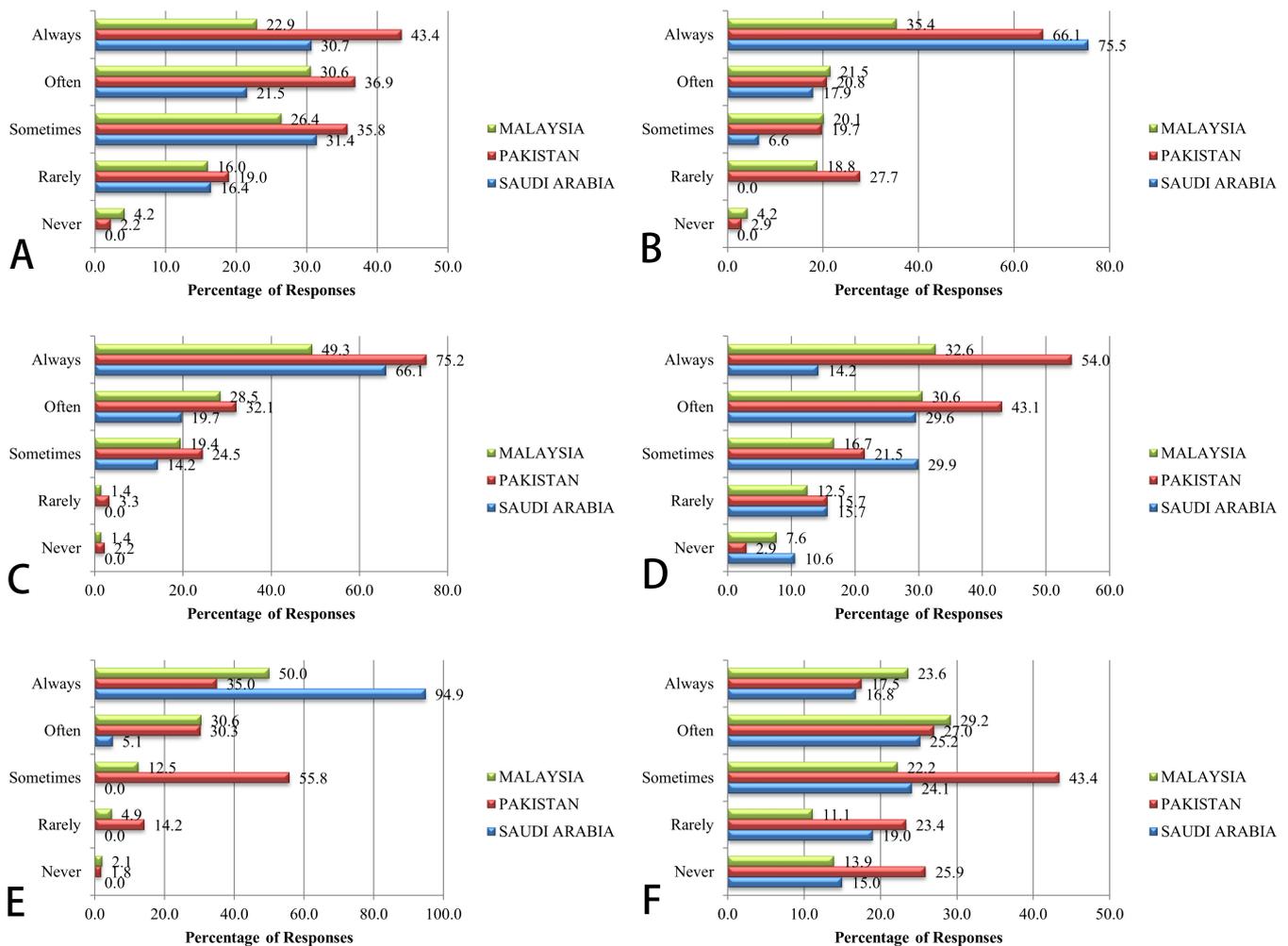
**FIGURE 3. The figures display responses of pediatric dentists from different populations attitude towards use of digital flow in pediatric dentistry. (A) Q7: Digital prosthetic solutions should be routinely integrated into pediatric dentistry. (B) Q8: Parents are more likely to choose digital prosthetic options over conventional ones for their children. (C) Q9: Digital prosthetics improve the appearance and acceptance of dental prostheses in children. (D) Q10: Cost is a major barrier preventing widespread use of digital prosthetics in pediatric patients. (E) Q11: I believe digital prosthetic solutions are more durable and reliable than conventional ones. (F) Q12: More training programs and workshops should be available for pediatric dentists on digital prosthetic techniques.**

While Malaysian dentists engage in these discussions less frequently, a substantial portion (35.4%, 21.5%) still report doing so “often” or “always” (Fig. 4B). Referral rates for digital treatments are high, with 66.1% in Saudi Arabia, 75.2% in Malaysia, and 49.3% in Pakistan referring patients “often” or “always” (Fig. 4C). Cost and accessibility pose significant challenges (Fig. 4D). A considerable percentage of dentists in all three countries face these hurdles, highlighting the need for practical solutions to facilitate broader adoption. There’s a strong intention to increase the use of digital techniques in the future, with almost all dentists in Saudi Arabia (94.9%) and a substantial portion in Pakistan (35%) and Malaysia (50%) planning to do so (Fig. 4E). While a fair number of dentists have participated in relevant training (16.8% “always” or “often” in Saudi Arabia, 17.5% in Pakistan and 23.6% in Malaysia), as shown in Fig. 4F, there’s a clear opportunity for expanding continuing education efforts given the high demand for skill development in this area.

A comparative statistical analysis revealed significant differences in knowledge levels across designations, including residents ( $p = 0.021$ ;  $0.031$ ;  $0.018$ ), senior residents ( $p = 0.039$ ;  $0.032$ ;  $0.041$ ), consultants ( $p = 0.047$ ;  $0.039$ ;  $0.040$ ), senior consultants ( $p = 0.029$ ;  $0.022$ ;  $0.036$ ) and others ( $p = 0.041$ ;  $0.044$ ;  $0.029$ ). However, Spearman’s correlation test indicated no significant relationship between awareness levels ( $r$  (interquartile range) =  $0.16$ ,  $p \geq 0.05$ ), attitudes ( $r$  (interquartile range) =  $0.21$ ,  $p \geq 0.05$ ), and practices ( $r$  (interquartile range) =  $0.22$ ,  $p \geq 0.05$ ) among practitioners across the three countries.

## 4. Discussion

Paediatric prosthetic dentistry is experiencing a paradigm shift with the advent of digital workflows, characterized by the integration of CAD/CAM technologies, intraoral scanners and 3D printing methodologies, which collectively enhance the precision, expedite the treatment timeline and optimize the



**FIGURE 4. The figures display responses of pediatric dentists from different populations practice towards use of digital flow in pediatric dentistry. (A) Q13: I use digital prosthetic solutions in my pediatric dental practice. (B) Q14: I discuss digital prosthetic options with parents of pediatric patients. (C) Q15: I refer pediatric patients for digital prosthetic treatments when necessary. (D) Q16: I face challenges (cost and accessibility) when using digital prosthetic solutions. (E) Q17: I plan to incorporate more digital prosthetic techniques into my practice in the future. (F) Q18: I have attended courses or workshops on digital prosthetic rehabilitation for pediatric patients.**

overall patient experience [6, 7].

The findings regarding paediatric dentists' knowledge of digital prosthetic solutions in Saudi Arabia, Malaysia, and Pakistan reveal key areas of strength and opportunities for improvement. While familiarity with core concepts like CAD/CAM and 3D printing is relatively high in Saudi Arabia and Pakistan, it's somewhat lower in Malaysia. This suggests a need for targeted educational interventions in Malaysia to raise awareness and understanding of these foundational technologies. Bakhurji and co-workers discussed the importance of paediatric dentists being knowledgeable about advancements in the field [7]. When it comes to the long-term success of digital prostheses in paediatric patients, respondents across all three countries demonstrated limited knowledge. This is in conjunction to the data reported by Elbashti *et al.* [5] and Radwan *et al.* [6]. This indicates the need for comprehensive research and dissemination of evidence to build confidence in the longevity and performance of these solutions.

Furthermore, the perception of digital prosthetics offering superior fit and accuracy is prevalent in Saudi Arabia and Pakistan. This positive view aligns with the general trend of dentists recognising the advantages of digital workflows, as highlighted in other sources [8, 9]. However, the less widespread adoption of this perspective in Malaysia may indicate a need for more evidence-based information and practical demonstrations to showcase the benefits of digital approaches. Researchers have provided examples of how digital technology enhances prosthetic fabrication and design [10, 11].

The relatively low levels of formal training across all three countries underscore a critical gap in professional development. This deficiency highlights the need for accessible training programmes and workshops to equip paediatric dentists with the necessary skills to confidently integrate digital technologies into their practices. The emphasis on training is echoed in various research which discusses the adoption of digital technologies in maxillofacial prosthetics [5, 12].

The widespread belief in the efficiency gains offered by

digital workflows, particularly in reducing chairside time, represents a strong motivator for adoption. This perceived benefit aligns with the desire for streamlined and patient-friendly treatment experiences. However, the varying levels of cost awareness across the three countries, with Saudi Arabia showing higher understanding than Pakistan and Malaysia, suggest the importance of incorporating cost-benefit analyses into educational initiatives. It provides context on the shift away from traditional materials and the factors driving these changes [13, 14].

Finally, the limited understanding of long-term success outcomes for digital prostheses highlights an area requiring further research and dissemination of evidence. The uncertainty expressed by many respondents underscores the importance of building a stronger evidence base to support clinical decision-making and inform discussions with parents. This highlights the evolving nature of the field and the need for continuous learning and adaptation.

Paediatric dentists in Saudi Arabia, Pakistan, and Malaysia demonstrate a largely positive attitude towards integrating digital prosthetics into their practices. A strong majority in both Saudi Arabia and Pakistan express a willingness to incorporate these technologies routinely, while Malaysia shows a positive, albeit slightly less enthusiastic, trend. This general embrace of digital workflows suggests a promising future for digital prosthetics in the region. Radwan and co-workers discuss the transformative potential of digital dental devices, impacting not only technology but also healthcare systems and treatment processes [6].

The perception of parental acceptance of digital prosthetic options was observed to be generally positive, with strong agreement in Saudi Arabia and Pakistan. The slightly more cautious outlook in Malaysia might stem from varying levels of parental awareness and exposure to digital dentistry. This highlights the importance of educating parents about the benefits and safety of these technologies. Abreu and co-workers noted the benefits of digital impressions, especially for young children with cleft lip and palate deformities, suggesting a potential area where parental acceptance could be high [15]. Across all three countries, there's a consensus on the aesthetic benefits of digital prosthetics, improving the appearance and acceptance of dental prostheses in children. This positive perception is crucial for patient satisfaction and treatment success. It has been suggested the use of digital technologies for minimally invasive rehabilitation, potentially enhancing aesthetics and patient acceptance [16]. However, cost remains a significant barrier to wider adoption, as acknowledged by dentists in all three countries. This financial constraint underscores the need for innovative financing solutions and cost-reduction strategies to improve accessibility and affordability. The high cost of digital technologies is a common challenge in dentistry, as mentioned in [6].

Despite the cost concerns, dentists express high confidence in the durability and reliability of digital prosthetics. This trust in the technology's performance is essential for continued adoption and integration into routine practice. The positive feedback reported in Bajunaid and co-workers research regarding the fit and occlusion of digital dentures reinforces this confidence in the technology's performance, albeit with a caveat

regarding aesthetics [17]. Finally, the overwhelming support for increased training opportunities highlights the recognised need for professional development in digital prosthetic techniques. It is suggested investing in training programmes and workshops will empower paediatric dentists with the necessary skills to effectively utilise these technologies, ultimately benefiting their patients. The researchers have emphasised the importance of understanding technology adoption patterns to guide innovation and ease the transition into digital workflows, which includes adequate training for practitioners [18, 19]. Elbashti and co-researchers indirectly support this need by highlighting the relatively small number of publications on digital technologies in maxillofacial prosthetics, potentially indicating a need for greater knowledge dissemination and training [19].

The survey results reveal a promising landscape for digital prosthetics in paediatric dentistry across Saudi Arabia, Malaysia, and Pakistan. While current utilisation rates vary, with Pakistan showing the highest adoption and Malaysia the lowest, a substantial portion of dentists in all three countries have already integrated digital prosthetics into their practices. This suggests a growing recognition of the potential benefits offered by these technologies. Nassani and the group support this observation, noting the increasing infiltration of CAD/CAM technology into Saudi dental practices [20].

The data also highlights a proactive approach to patient communication, with a majority of dentists in Saudi Arabia and Pakistan frequently discussing digital options with parents. While Malaysian dentists engage in these discussions less often, a notable portion still incorporates them into their consultations. This open communication is crucial for educating parents and fostering acceptance of digital solutions. This could be most likely due to doctors in Saudi Arabia and Pakistan sharing the same language vocabulary and cultural values, making conversations more natural and trust easier to build, whereas Malaysia's diverse population can sometimes lead to language barriers and differing expectations in healthcare. Alsharif in his research provided context regarding the current dental service landscape in Saudi Arabia, where access to complex treatments might be limited for certain demographics [21]. This emphasises the importance of discussions regarding alternative options like digital prosthetics. Referral rates for digital treatments are consistently high across all three countries, indicating a willingness to utilise specialised services and leverage advanced technologies. This suggests that the infrastructure and expertise for digital prosthetic fabrication are becoming increasingly available in the region.

Despite these positive trends, cost and accessibility remain significant challenges. The financial barrier to adopting digital workflows is a common concern in dentistry [6], highlighting the need for affordable solutions and innovative financing models. Addressing these hurdles will be crucial for promoting wider adoption, especially in countries like Pakistan where cost concerns appear more pronounced.

The strong intention to increase the use of digital techniques in the future demonstrates a clear commitment to embracing technological advancements. This forward-looking perspective, particularly strong in Saudi Arabia, bodes well for the future of digital prosthetics in the region.

Finally, while a significant number of dentists have already participated in relevant training, the data reveals a need for expanded continuing education efforts. This aligns with the general trend of dentists recognising the importance of professional development in digital dentistry, as highlighted in other research focused on the adoption of these new technologies. Further investigation and publication of long-term outcomes will be crucial for building confidence and promoting wider adoption of digital prosthetic solutions in paediatric dentistry. The digital workflow highlighted by researchers might offer valuable insights into this area [22].

## 5. Limitations and future directions

The cross-sectional design provides a snapshot of current knowledge and practices but does not track changes over time. Longitudinal studies would be beneficial in assessing how training initiatives, technological advancements, and cost reductions impact adoption rates in the long run.

Moreover, while the study included three countries with different healthcare infrastructures and cultural influences, the findings may not be generalizable to other regions with different economic conditions, levels of technological access or professional training structures. Future research should expand the geographical scope to include diverse populations, offering a more comprehensive understanding of global adoption trends.

To enhance the impact of this research, future studies should incorporate qualitative methodologies, such as in-depth interviews or observational studies, to gain richer insights into the motivations, barriers, and real-world experiences of pediatric dentists using digital workflows. Observing clinical workflows in practice could provide a more nuanced understanding of how digital technologies are integrated or why they are resisted in daily patient care. Additionally, interviews with parents could shed light on their perceptions, concerns, and willingness to opt for digital prosthetic solutions for their children.

## 6. Conclusions

In conclusion, the survey findings paint a promising picture of the current and future landscape of digital prosthetics in pediatric dentistry across Saudi Arabia, Malaysia and Pakistan. While challenges related to cost and accessibility remains, the strong interest, growing adoption, and commitment to continued learning among practitioners suggest that digital solutions are poised to play an increasingly pivotal role in the provision of high-quality, accessible and personalized prosthetic care for pediatric patients in the region [5, 6].

## ABBREVIATIONS

SA, Saudi Arabia; MY, Malaysia; PK, Pakistan; CAD, Computer-aided design; CAM, computer-aided manufacturing; 3D, three-dimensional; KAP, Knowledge, attitude and practice.

## AVAILABILITY OF DATA AND MATERIALS

Detailed data is available in the materials and methods section.

## AUTHOR CONTRIBUTIONS

ZQ, MS, NSA and CS—designed the research study. ZQ, RNR, AHA, HMKK, NHS and MN—performed the research. ZQ, SMHM, NL and MS—provided help and advice on improving the sample size. NSA 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 (FRP/2025/571). All the participants signed the consent form.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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