Dentomaxillofacial Radiology, 2026, 1–17
https://doi.org/10.1093/dmfr/twag052
Advance access publication: July 23, 2026
Research Article

Multinational survey of pediatric dentists' knowledge and clinical practices in dentomaxillofacial imaging

Berkant Sezer, DDS, MSc[1,*], Gamze Coşan Ata, DDS, MSc[2], Canan Duman, DDS, PhD[3], Hakan Eren, DDS, PhD[2], Ola B. Al-Batayneh, BDS, MDSc, JDB, FRACDS (PAED)[4,5], Yousef Khader, BDS, MSc, MSPH, MHPE, FFPH, ScD[6], Heba Sabbagh, BDS, MSc, PhD[7], Sajjad Ahmad, DCD, MSc[8], Angelika Kobylińska, MD, PhD[9], Alvaro García Pérez, DDS, MSc, PhD[10], Marwa Baraka, BDS, MSc, PhD[11], Majd Alsaleh, DDS, MS, FAGD[12]

[1]Department of Pediatric Dentistry, School of Dentistry, Çanakkale Onsekiz Mart University, Çanakkale 17100, Türkiye
[2]Department of Dentomaxillofacial Radiology, School of Dentistry, Çanakkale Onsekiz Mart University, Çanakkale 17100, Türkiye
[3]Private Practice, Muğla 48400, Türkiye
[4]Department of Preventive Dentistry, Faculty of Dentistry, Jordan University of Science and Technology, Irbid 22110, Jordan
[5]Department of Orthodontics, Pediatric and Community Dentistry, College of Dental Medicine, University of Sharjah, Sharjah 27272, United Arab Emirates
[6]Department of Public Health and Epidemiology, Faculty of Medicine, Jordan University of Science and Technology, Irbid 22110, Jordan
[7]Department of Pediatric Dentistry, Faculty of Dentistry, King Abdulaziz University, Jeddah 21589, Saudi Arabia
[8]Department of Paediatric Dentistry, Khyber College of Dentistry, Peshawar 25000, Pakistan
[9]Department of Pediatric Dentistry, Medical University of Warsaw, Warsaw 02-091, Poland
[10]Laboratory of Public Health Research, Faculty of Higher Studies (FES), National Autonomous University of Mexico (UNAM), Iztacala 54090, Mexico
[11]Department of Pediatric Dentistry and Dental Public Health, Alexandria University, Alexandria 21526, Egypt
[12]Department of Pediatric Dentistry, College of Dentistry, University of Illinois, Chicago, IL 60612, United States
*Corresponding author: Berkant Sezer, DDS, MSc, Department of Pediatric Dentistry, School of Dentistry, Çanakkale Onsekiz Mart University, Cumhuriyet Mah., Sahilyolu Cd., No:5, 17100 Çanakkale, Türkiye (dt.berkantsezer@gmail.com; berkant.sezer@comu.edu.tr).

Abstract

Objectives: **This study aimed to evaluate pediatric dentists' knowledge and clinical practices regarding dentomaxillofacial imaging, with particular emphasis on guideline-consistent indication selection, radiation protection, and dose-optimization principles, in accordance with established international guidelines (EAPD, AAPD, and DIMITRA).**

Methods: **A structured cross-sectional questionnaire was distributed to pediatric dentists from 8 countries (Egypt, Jordan, Mexico, Pakistan, Poland, Saudi Arabia, Türkiye, and the United States) through a convenience and snowball sampling approach. The survey assessed knowledge of radiation protection, radiographic parameters, cone-beam CT (CBCT) indications and resolution selection, and routine clinical practices. Descriptive and comparative statistical analyses were performed.**

Results: **A total of 488 pediatric dentists participated, with a mean knowledge score of 39.9 ± 4.7, and 75.8% demonstrated moderate knowledge. Awareness of dose-reduction strategies was limited, as 41.6% identified rectangular collimation as the most effective radiation protection measure and 17.7% recognized its impact on radiation dose. Knowledge of dose-optimization principles varied: 68.0% of respondents demonstrated knowledge of the ALARA/ALADA principle, whereas 46.5% demonstrated knowledge of the ALADAIP concept. Clinical practices showed patterns that were partially consistent with guideline recommendations. Regarding CBCT, 57.4% had not received formal training, 43.6% were uncertain about appropriate field-of-view selection, and 91.0% reported fewer than 5 scans per month.**

Conclusions: **Pediatric dentists demonstrated moderate radiation knowledge but inconsistent application of radiation protection principles. These findings indicate a gap between theoretical knowledge and clinical practice. Targeted, practice-oriented education is needed to improve dose optimization and CBCT-related decision-making. Findings should be interpreted with caution due to the non-probability sampling design.**

Advances in knowledge: **This multinational study highlights persistent gaps in pediatric dental imaging practices and supports the need for standardized, competency-based training to improve radiation safety.**

Key words pediatric radiology, ALARA, radiation protection, dentomaxillofacial imaging, pediatric dentistry, ALADAIP

Received: January 29, 2026. **Revised:** April 22, 2026. **Accepted:** July 21, 2026
© The Author(s) 2026. Published by Oxford University Press on behalf of the British Institute of Radiology and the International Association of Dentomaxillofacial Radiology.
This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial License (https://creativecommons.org/licenses/by-nc/4.0/), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact reprints@oup.com for reprints and translation rights for reprints. All other permissions can be obtained through our RightsLink service via the Permissions link on the article page on our site—for further information please contact journals.permissions@oup.com.

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

Introduction

Dental radiography is an essential diagnostic tool in pediatric dentistry for the assessment of dental caries, traumatic dental injuries, developmental dental anomalies, and other dentomaxillofacial conditions. Radiographic examinations play a critical role in early diagnosis and treatment planning; however, their application in children differs from that in adults due to limited cooperation, unique developmental anatomy, and higher susceptibility to disease.[1,2] Dentomaxillofacial imaging methods that involve ionizing radiation, such as intraoral and extraoral radiography and cone-beam CT (CBCT), are therefore integral to pediatric dental practice. However, these modalities should be applied with caution, particularly in pediatric patients, who are significantly more sensitive to radiation and face a higher cumulative lifetime risk.[3-5]

Children are more vulnerable to the harmful effects of ionizing radiation than adults due to their higher cell division rates, a greater proportion of rapidly proliferating tissues, and the longer expected lifespan after exposure.[6] Although effective doses from routine dental radiographs are generally low, stochastic risks from DNA damage may accumulate over time, potentially increasing lifetime cancer risk, especially in radiation-sensitive organs such as the thyroid gland, bone marrow, and salivary glands.[7,8] In pediatric dental imaging, increased tissue radiosensitivity and the cumulative nature of radiation exposure over a longer lifespan, together with the potential need for repeated examinations in cases of caries, trauma, or developmental anomalies, contribute to a greater cumulative radiation burden and associated long-term stochastic risk.[9] Recent studies have reported measurable cytotoxic changes in the oral mucosa of children after panoramic radiography; however, the clinical relevance of these findings remains uncertain and is generally considered limited.[10] Therefore, strict adherence to radiation protection principles, including appropriate selection criteria, adjustment of exposure parameters (kilovolt peak [kVp], milliampere [mA], and exposure time), and use of rectangular collimation is essential to ensure that pediatric imaging is performed safely and only when clinically justified.[10]

International guidelines increasingly emphasize individualized, evidence-based decision-making when prescribing radiographs for children. The European Academy of Paediatric Dentistry (EAPD) recommends that radiographic examinations follow the ALADAIP principle—*As Low As Diagnostically Acceptable, Indication-oriented and Patient-specific*—highlighting that routine screening is inappropriate and exposure parameters should be tailored to each child's clinical needs.[11,12] Similarly, the American Academy of Pediatric Dentistry (AAPD) emphasizes that radiographs should be selected based on diagnostic need rather than patient age, and emphasizes minimizing radiation dose and optimizing exposure settings.[2] With respect to CBCT, the DIMITRA project indicates that indications for CBCT in pediatric patients remain limited, and concerns persist regarding the higher radiation dose and inconsistent implementation of dose-reduction strategies. The project advocates an integrated, indication-oriented approach that prioritizes reduced field-of-view (FOV), optimized exposure parameters, and strict avoidance of unnecessary examinations.[4] A systematic review found no strong evidence supporting routine CBCT use in children, highlighting the need for studies on its diagnostic efficacy.[13] Collectively, these guidelines underscore that pediatric imaging requires clear justification and optimized protocols, yet evidence indicates considerable variability in practice across clinicians and regions.

Despite these recommendations, existing research has largely focused on general dentists or single-country cohorts, with limited data on pediatric dentists, who manage a population that is more behaviorally challenging, more vulnerable to radiation, and more likely to require imaging for caries, trauma, developmental anomalies, and growth assessment. Advances in digital radiography and increasing CBCT availability add complexity to pediatric imaging decisions; however, little is known about how appropriately these modalities are selected and used in daily practice. Importantly, to our knowledge, no prior studies have examined pediatric dentists' knowledge and radiographic practices across multiple countries using a unified framework. This gap underscores the need for an international assessment to understand current practices, identify discrepancies in guideline adherence, and evaluate whether pediatric dentists optimize imaging parameters and radiation protection strategies for children.

Therefore, the present study aimed to evaluate the knowledge and clinical practices of pediatric dentists regarding radiation-based dentomaxillofacial imaging across several countries. Specifically, this survey assessed their familiarity with exposure parameters, dose-reduction strategies, protective measures, and justification principles, as well as how these practices compare with international guideline recommendations. The null hypothesis was that pediatric dentists' knowledge and practices in radiation-based dentomaxillofacial imaging do not differ across countries.

Methods

Ethical considerations

This study was conducted in accordance with the Declaration of Helsinki. Ethical approval for the primary research protocol was obtained from the Non-Interventional Clinical Research Ethics Committee of Çanakkale Onsekiz Mart University (Approval No: 08/45, Date: 30 May 2024). Participation was entirely voluntary, and all respondents provided electronic informed consent prior to accessing the survey. No identifying personal data were collected, and all responses were analyzed anonymously and stored securely. As this was a multi-country survey, investigators from participating countries additionally obtained institutional or local permissions when required by their respective national regulations or institutional policies. The study involved minimal risk, as no clinical procedures or patient data were involved.

Study design and setting

This research was designed as a cross-sectional, survey-based study aimed at evaluating pediatric dentists' knowledge and clinical practices regarding radiation-based dentomaxillofacial imaging. The study was conducted across 8 countries: Egypt, Jordan, Mexico, Pakistan, Poland, Saudi Arabia, Türkiye, and the United States, to capture potential international variability in imaging

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

behaviors and adherence to radiation protection principles. Data were collected using an online survey distributed from March 2025 to October 2025 through professional networks, national pediatric dentistry societies, academic institutions, and commonly used digital communication platforms.

Participants and recruitment

The participants were licensed pediatric dentists who were actively involved in the clinical management of children in their respective countries. Eligibility criteria included having completed formal training in pediatric dentistry and providing direct patient care; dentists who were still in predoctoral training or not engaged in clinical practice were excluded. Recruitment was conducted through a convenience and snowball sampling approach, via national pediatric dentistry associations, academic institutional mailing lists, social media groups, and personal networks of the local investigators in each participating country. Due to this non-probability sampling strategy, a complete sampling frame could not be established, and the total number of pediatric dentists in each country could not be determined. Pediatric dentists were invited to participate voluntarily and anonymously through an online survey link, and no incentives were offered. A total of 488 respondents from 8 countries completed the questionnaire and were included in the final analysis.

Sample size calculation

G*Power statistical software (version 3.1.9.7; Heinrich Heine University Düsseldorf, Düsseldorf, Germany) was used to perform the sample size calculation. The estimation was based on data from a previous study[14] in which kVp selection was evaluated in relation to years of professional experience. In that study, among pediatric dentists with less than 5 years of experience, 15% preferred tube voltages below 60 kVp, whereas 59% were unfamiliar with the settings ($P < .05$). Using these proportions as input parameters and setting the significance level (α) at .05 and statistical power at .95, the minimum required sample size was calculated to be 54 participants per country.

Survey structure and development

The survey was developed through a multi-stage, evidence-based process grounded in major international guidelines for pediatric dentomaxillofacial imaging. The research team reviewed the recommendations of the EAPD,[11] the AAPD,[15] and the DIMITRA project position statement on conventional radiography and CBCT in children,[4] as well as previously published surveys on dental practitioners' radiographic knowledge and practices, to ensure comprehensive coverage of key domains.[16-18]

An initial pool of 48 questions was drafted by the coordinating team to evaluate sociodemographic characteristics, knowledge of radiation protection and imaging, and clinical practices related to pediatric dentomaxillofacial imaging. To ensure content validity, the preliminary questionnaire was subjected to Content Validity Index (CVI) analysis. A panel of 20 experts, including pediatric dentists and dentomaxillofacial radiologists with at least 10 years of experience, evaluated each item and its response options for relevance and clarity. Three questions with item-level CVI values below 0.70 and 2 questions with insufficiently rated response options were eliminated. The remaining 43 items demonstrated CVI values above 0.80, confirming the adequacy, clarity, and representativeness of the questionnaire content for assessing pediatric dentists' knowledge and practices regarding radiation-based dentomaxillofacial imaging.

The first part of the survey included 5 items addressing gender, age range, country of practice, years of professional experience in pediatric dentistry, and whether participants had received any postgraduate training in dentomaxillofacial radiology or radiation protection.

The second part consisted of 13 questions designed to assess participants' knowledge of collimation types, the effect of rectangular collimation on radiation dose, differences between image receptor systems, exposure parameters, appropriate indications for periapical, panoramic, and CBCT imaging in children, and awareness of the *As Low as Reasonably Achievable* (ALARA) and ALADAIP principles. This knowledge domain comprised both objective (scored) items assessing factual understanding and self-reported items evaluating participants' familiarity with key concepts and device-related parameters. This section included both single-correct-answer items and multiple-response questions requiring participants to select all correct options. For single-answer questions, correct responses were assigned a score of 1, and incorrect responses were assigned 0. For multiple-response questions, each correct option selected was assigned a score of 1, whereas incorrect selections and unselected correct options were assigned a score of 0. This scoring approach allowed knowledge to be assessed across individual response options and ensured that all items contributed to the total score. Using this method, the maximum possible knowledge score was 73 points, and the minimum possible score was 0. After calculating the total knowledge scores for all participants, a 3-level classification system was applied to categorize overall knowledge performance. Because the knowledge items varied in structure, answer format, and number of correct responses, and the primary goal was to evaluate the extent to which pediatric dentists met internationally recommended knowledge thresholds, a percentage-based cutoff system was used rather than a distribution-based approach. Participants who scored below 50% of the maximum score (<37) were classified as having low knowledge. Scores between 50% and 70% of the maximum (≥ 37 and ≤ 51) were categorized as moderate knowledge, while scores exceeding 70% of the maximum (>51) were classified as high knowledge.

The final part of the survey contained 25 questions exploring pediatric dentists' clinical imaging practices. These questions covered work setting, the radiographic devices and protective equipment available in the workplace, whether exposure parameters were adjusted for pediatric patients, the average weekly number of patients examined, the frequency of prescribing periapical, panoramic, and CBCT radiographs, the radiographic techniques that clinicians performed independently, and the most common clinical indications for each imaging modality, represented through 15-item indication lists. Participants could select multiple options for indications of periapical and panoramic radiography, and CBCT scans in pediatric patients.

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

The full questionnaire as presented to participants is provided in the Supplementary Material.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics software (version 28.0; IBM Corp., Armonk, NY, United States). Sociodemographic and professional variables were summarized using frequencies and percentages, since all items in this section were categorical. Knowledge scores were treated as continuous numerical variables, and descriptive statistics were presented as means, SDs, and ranges. The 3-level knowledge classification (low, moderate, and high) derived from percentage-based cutoff values was analyzed as a categorical variable.

The normality of the total knowledge score distribution was assessed using the Kolmogorov-Smirnov test, indicating that the data followed a normal distribution. Homogeneity of variances across countries was confirmed using Levene's test. Therefore, comparisons of mean knowledge scores among the 8 participating countries were performed using 1-way ANOVA, followed by Tukey's *post hoc* test for pairwise group comparisons. Ninety-five percent confidence intervals (95% CI) for group means were calculated and displayed graphically to illustrate between-country differences.

Categorical comparisons of knowledge level groups (low, moderate, high) across countries were conducted using Pearson's chi-square test. For the practice section, which included multiple-response items with up to 15 selectable options for several questions, analyses were carried out using the SPSS Multiple Response procedure, and results were reported as the percentage of cases selecting each option. Additional descriptive analyses, including bar charts and distribution plots, were used to illustrate the frequency of indications for periapical, panoramic, and CBCT imaging. Alignment with guideline recommendations was assessed descriptively by comparing participants' responses with established guideline frameworks (eg, EAPD, AAPD, and DIMITRA) and was not analyzed as a predefined statistical outcome. A *P*-value of $<.05$ was considered statistically significant for all analyses.

Results

Participants' characteristics

A total of 488 pediatric dentists from 8 countries participated in the study. Of these, 55 were from Egypt (11.3%), 75 from Jordan (15.4%), 57 from Mexico (11.7%), 57 from Pakistan (11.7%), 57 from Poland (11.7%), 75 from Saudi Arabia (15.4%), 58 from Türkiye (11.9%), and 54 from the United States (11.1%).

Of all respondents, 73.2% were female ($n = 357$). The most common age group was 25-29 years (28.7%), followed by 30-34 years (23.0%) and 35-39 years (19.5%). Regarding professional experience, 41.8% of participants had <5 years of experience, 38.5% had 5-15 years, and only 8% had more than 25 years of experience. One-third of participants (33.8%) reported receiving postgraduate training in dental radiology or radiation protection, whereas 66.2% had not. This diverse and geographically distributed sample represents a broad spectrum of clinical backgrounds and experience levels, providing a comprehensive overview of pediatric dentists' knowledge and imaging practices across multiple healthcare systems. All sociodemographic characteristics of the participants are summarized in Table 1.

Knowledge results

The total knowledge scores of the participants ranged from 25 to 53, with an overall mean of 39.9 ± 4.7. The distribution of scores demonstrated adequate variability across individuals, reflecting a wide spectrum of familiarity with dentomaxillofacial imaging principles. When examined by country, mean knowledge scores varied significantly (ANOVA, $P < .001$), with higher averages observed among participants from Türkiye, Poland, Jordan, the United States, and Saudi Arabia, and lower averages among those from Mexico and Pakistan. Levene's test confirmed homogeneity of variances ($P = .242$), supporting the use of ANOVA for between-country comparisons. Detailed country-specific mean values and 95% CIs are presented in Figure 1.

Based on the percentage-based cutoff system, most participants demonstrated a moderate level of knowledge. Overall, 23.8% of the respondents ($n = 116$) were classified as having low knowledge, 75.8% ($n = 370$) as moderate knowledge, and only 0.4% ($n = 2$) as high knowledge. The distribution of knowledge levels differed significantly across countries ($\chi^2 = 52.69$, df = 14, $P < .001$). Low knowledge levels were most prevalent in Pakistan (50.9%) and Mexico (40.4%). The moderate knowledge level dominated in all countries, reaching the highest proportion in the United States (90.7%) and Poland (89.5%). High knowledge was only achieved by participants in 2 countries: Jordan and Türkiye (1.3% and 1.7%, respectively). The country-specific distribution of knowledge levels is presented in Figure 2.

Practice results

Practice-related responses are summarized in Table 2. Figures 3, 4, and 5 present the reported clinical indications for periapical radiography, panoramic radiography, and CBCT, respectively. Overall, most participants reported working in hospital or university settings, and the availability of radiographic equipment was high across the sample. Digital intraoral radiography was the most commonly available modality, and cylindrical tube heads were predominantly used. Responsibility for radiation protection varied across institutions, most frequently attributed to pediatric dentists or dentomaxillofacial radiologists.

Despite the widespread availability of imaging infrastructure, gaps were identified in radiation protection practices and CBCT-related training. A considerable proportion of participants reported a lack of protective equipment or formal training in CBCT reporting. In addition, uncertainty regarding CBCT imaging parameters and FOV selection was relatively high. Clinical workload and imaging frequency varied among participants; however, CBCT use in pediatric practice remained limited. Conventional radiographic techniques were generally performed independently by clinicians, whereas CBCT was infrequently used.

Regarding periapical radiography in pediatric patients (Figure 3), the most frequently reported indications were supernumerary teeth, hypodontia, and suspected tooth impaction, whereas invasive cervical resorption, acute dental infection, and

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

Table 1 Sociodemographic and professional characteristics of the participants.

	Total participants (*N* = 488) *N* (%)	Egypt (*N* = 55) *N* (%)	Jordan (*N* = 75) *N* (%)	Mexico (*N* = 57) *N* (%)	Pakistan (*N* = 57) *N* (%)	Poland (*N* = 57) *N* (%)	Saudi Arabia (*N* = 75) *N* (%)	Türkiye (*N* = 58) *N* (%)	United States (*N* = 54) *N* (%)
Gender									
Male	130 (26.6)	8 (14.5)	12 (16)	18 (31.6)	28 (49.1)	5 (8.8)	31 (41.3)	13 (22.4)	15 (27.8)
Female	357 (73.2)	47 (85.5)	63 (84)	39 (68.4)	29 (50.9)	52 (91.2)	44 (58.7)	44 (75.9)	39 (72.2)
Other	1 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.7)	0 (0.0)
Age range									
25-29	140 (28.6)	10 (18.2)	19 (25.3)	32 (56.1)	26 (45.6)	8 (14)	11 (14.7)	26 (44.8)	8 (14.8)
30-34	112 (23.0)	16 (29.1)	20 (26.7)	11 (19.3)	10 (17.5)	11 (19.3)	19 (25.3)	17 (29.3)	8 (14.8)
35-39	95 (19.5)	15 (27.3)	14 (18.7)	7 (12.3)	9 (15.8)	15 (26.3)	16 (21.3)	8 (13.8)	11 (20.4)
40-44	61 (12.5)	6 (10.9)	10 (13.3)	6 (10.5)	3 (5.3)	9 (15.8)	15 (20)	4 (6.9)	8 (14.8)
45-49	28 (5.7)	6 (10.9)	7 (9.3)	1 (1.8)	0 (0.0)	3 (5.3)	7 (9.3)	0 (0.0)	4 (7.4)
>49	52 (10.7)	2 (3.6)	5 (6.7)	0 (0.0)	9 (15.8)	11 (19.3)	7 (9.3)	3 (5.2)	15 (27.8)
Professional experience (years)									
<5	204 (41.8)	13 (23.6)	34 (45.3)	35 (61.4)	34 (59.6)	13 (22.8)	24 (32)	31 (53.4)	20 (37)
5-10	120 (24.6)	21 (38.2)	16 (21.3)	12 (21.1)	11 (19.3)	14 (24.6)	25 (33.3)	13 (22.4)	8 (14.8)
11-15	68 (13.9)	7 (12.7)	11 (14.7)	7 (12.3)	5 (8.8)	14 (24.6)	10 (13.3)	6 (10.3)	8 (14.8)
16-20	35 (7.2)	7 (12.7)	6 (8)	3 (5.3)	1 (1.8)	4 (7)	8 (10.7)	4 (6.9)	2 (3.7)
21-25	22 (4.5)	5 (9.1)	5 (6.7)	0 (0.0)	1 (1.8)	3 (5.3)	3 (4)	2 (3.4)	3 (5.6)
>25	39 (8.0)	2 (3.6)	3 (4)	0 (0.0)	5 (8.8)	9 (15.8)	5 (6.7)	2 (3.4)	13 (24.1)
Have you taken any courses/training in dentomaxillofacial radiology or radiation protection after graduation?									
No	323 (66.2)	41 (74.5)	65 (86.7)	40 (70.2)	46 (80.7)	9 (15.8)	52 (69.3)	39 (67.2)	31 (57.4)
Yes	165 (33.8)	14 (25.5)	10 (13.3)	17 (29.8)	11 (19.3)	48 (84.2)	23 (30.7)	19 (32.8)	23 (42.6)

N: number.

trauma-related resorption were among the least selected. For panoramic radiography (Figure 4), tooth fractures and luxation injuries and trauma-related resorption were the most commonly reported indications, followed by acute dental infection. In contrast, cleft lip and palate, condylar morphology in temporomandibular dysfunction, and hereditary dental anomalies were among the least frequently selected. For CBCT (Figure 5), the most frequently reported indications were cysts and benign tumors, severe dental trauma, and supernumerary teeth. In contrast, molar incisor hypomineralization, caries detection, and hereditary dental anomalies were rarely selected as indications.

Discussion

This multinational study provides a comprehensive evaluation of pediatric dentists' knowledge and clinical practices related to radiation-based dentomaxillofacial imaging and offers important insight into how guideline-based principles are translated into real-world clinical decision-making. Overall, the findings indicate that, although participants demonstrated a generally moderate level of knowledge and their reported practices showed partial consistency with international recommendations when interpreted in relation to established guidelines, considerable variability persists in both imaging practices and the application of radiation-protection strategies across different clinical contexts.

A central finding of the present study is the discrepancy between knowledge and clinical implementation. While participants demonstrated familiarity with general imaging concepts and major indications, this did not consistently translate into guideline-concordant behavior, particularly in areas requiring more complex or parameter-dependent decision-making, such as CBCT use, exposure optimization, and modality selection. This pattern likely reflects the multifactorial nature of radiographic decision-making in pediatric dentistry, where clinicians must balance diagnostic needs with radiation safety, patient cooperation, and technical feasibility. In such situations, decision-making may be shaped not only by theoretical knowledge but also by experience-based reasoning, clinical pragmatism, and environmental constraints.

Previous studies investigating pediatric dentists' knowledge and imaging practices are relatively scarce, and existing evidence is often limited to single-country evaluations focusing on digital radiography or CBCT. Earlier reports from Türkiye,[16] the

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

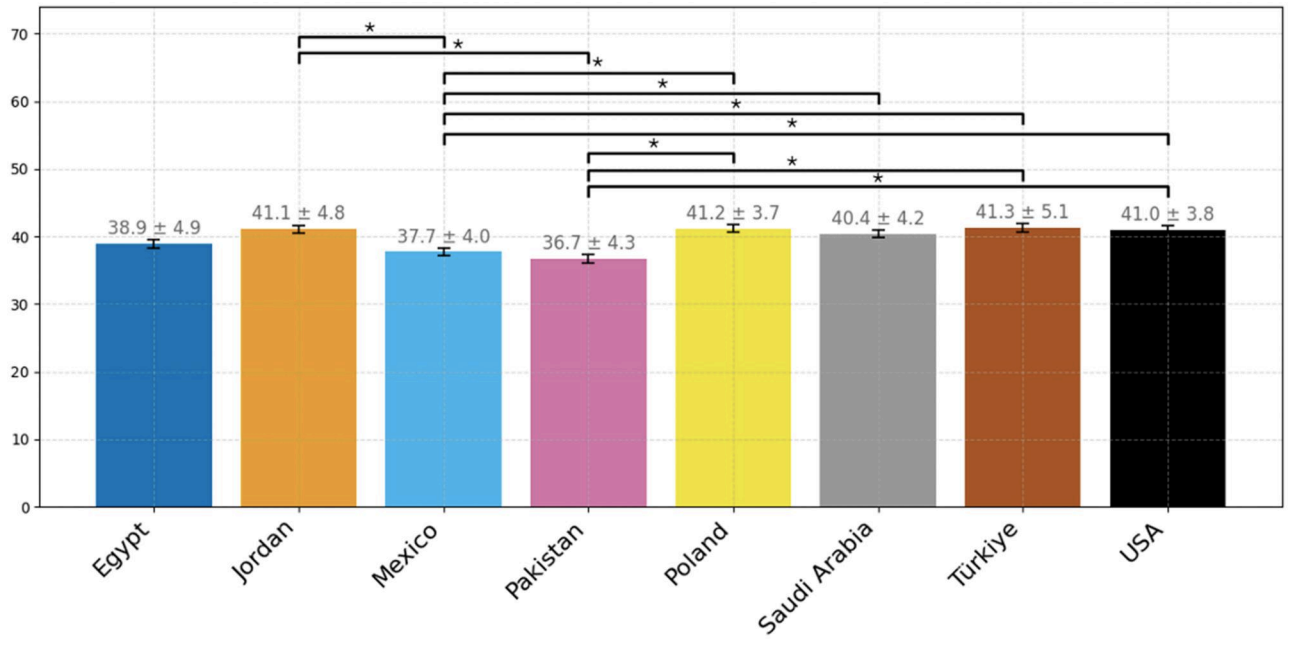


Figure 1 Comparison of mean knowledge scores across countries. (Bars represent mean ± SD. Lines above bars and asterisks indicate statistically significant pairwise differences ($P < .05$).).

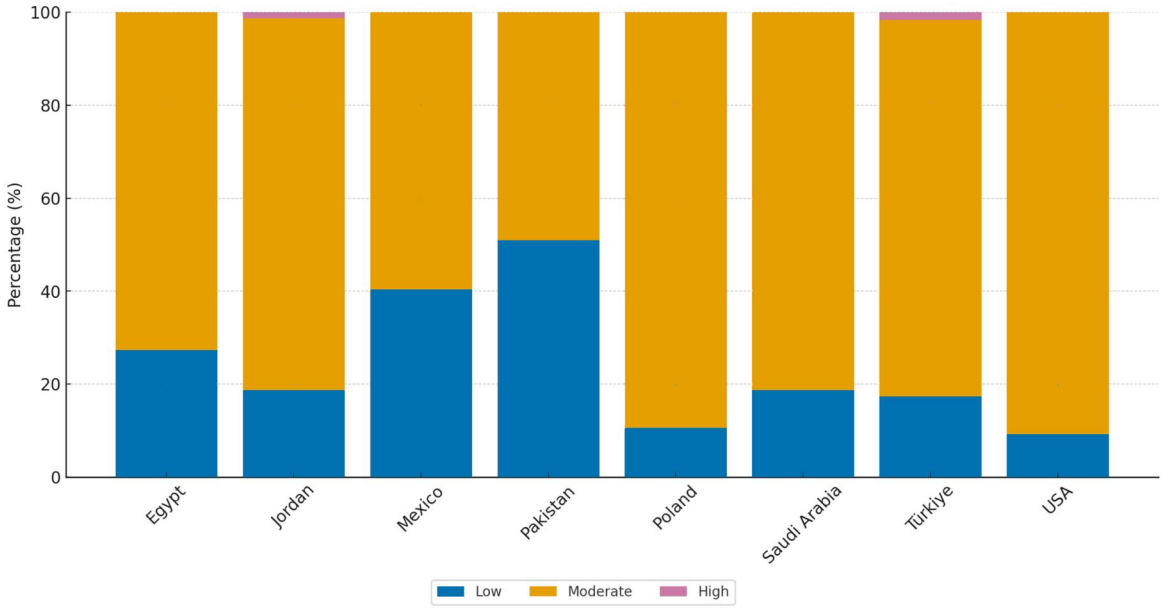


Figure 2 Distribution of knowledge levels (low, moderate, high) by country. (Stacked bar chart displaying the proportion of participants in each knowledge category across eight countries.).

United States,[19] and broader European cohorts[14] consistently revealed gaps in awareness of radiation guidelines, limited familiarity with dose-reduction strategies, and inconsistent adherence to recommended practices such as rectangular collimation or appropriate shielding use. The present findings are broadly consistent with this pattern, suggesting that variability in pediatric dental imaging practices is not confined to specific regions but reflects a more widespread issue. This variability may be explained by differences in training structures, the lack of standardized curricula in pediatric dental radiology, and the uneven integration of updated guidelines into clinical education. In addition, the rapid evolution of imaging technologies may further contribute to these discrepancies, as clinicians may struggle to keep pace with changing recommendations, particularly in areas where guidance is nuanced or evolving.

Studies conducted among general dentists and mixed dental populations further reinforce these findings. Research from several countries[20-24] has consistently demonstrated inadequate knowledge of CBCT indications, limited understanding of technical parameters, and inconsistent use of fundamental radiation

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

Table 2 Distribution of responses to practice-related questions among pediatric dentists.

	Total participants (*N* = 488) *N* (%)	**Egypt (*N* = 55) *N* (%)**	**Jordan (*N* = 75) *N* (%)**	**Mexico (*N* = 57) *N* (%)**	**Pakistan (*N* = 57) *N* (%)**	**Poland (*N* = 57) *N* (%)**	**Saudi Arabia (*N* = 75) *N* (%)**	**Türkiye (*N* = 58) *N* (%)**	**United States (*N* = 54) *N* (%)**
What is your working type as a pediatric dentist?									
Private practice—solo	107 (21.9)	12 (21.8)	11 (14.7)	33 (57.9)	10 (17.5)	16 (28.1)	4 (5.3)	6 (10.3)	15 (27.8)
Private practice—polyclinic	140 (28.7)	18 (32.7)	16 (21.3)	20 (35.1)	8 (14.0)	36 (63.2)	9 (12.0)	13 (22.4)	20 (37.0)
Hospital setting/University	326 (66.8)	46 (83.6)	48 (64.0)	16 (28.1)	50 (87.7)	29 (50.9)	66 (88.0)	43 (74.1)	28 (51.9)
Do you have radiographic equipment at your workplace?									
No	12 (2.5)	3 (5.5)	1 (1.3)	6 (10.5)	0 (0.0)	1 (1.8)	0 (0.0)	1 (1.7)	0 (0.0)
Yes	468 (95.9)	51 (92.7)	74 (98.7)	48 (84.2)	57 (100.0)	56 (98.2)	74 (98.7)	54 (93.1)	54 (100.0)
Unsure	8 (1.6)	1 (1.8)	0 (0.0)	3 (5.3)	0 (0.0)	0 (0.0)	1 (1.3)	3 (5.2)	0 (0.0)
Which radiography equipment is available at your workplace?									
Conventional intraoral radiography	206 (42.2)	38 (69.1)	27 (36.0)	30 (52.6)	36 (63.2)	16 (28.1)	24 (32.0)	22 (37.9)	13 (24.1)
Digital intraoral radiography	376 (77.0)	36 (65.5)	59 (78.7)	35 (61.4)	39 (68.4)	47 (82.5)	71 (94.7)	39 (67.2)	50 (92.6)
Hand-held intraoral radiography	144 (29.5)	21 (38.2)	16 (21.3)	7 (12.3)	24 (42.1)	9 (15.8)	20 (26.7)	7 (12.1)	40 (74.1)
Extraoral radiography	326 (66.8)	17 (30.9)	54 (72.0)	5 (8.8)	37 (64.9)	49 (86.0)	71 (94.7)	43 (74.1)	50 (92.6)
Cone-beam CT (CBCT)	211 (43.2)	12 (21.8)	18 (24.0)	3 (5.3)	23 (40.4)	41 (71.9)	60 (80.0)	31 (53.4)	23 (42.6)
Other	2 (0.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.4)	0 (0.0)
Unsure	11 (2.3)	3 (5.5)	0 (0.0)	2 (3.5)	0 (0.0)	1 (1.8)	2 (2.7)	3 (5.2)	0 (0.0)
Which radiation protection equipment is available at your workplace?									
Thyroid shield	273 (55.9)	8 (14.5)	25 (33.3)	32 (56.1)	9 (15.8)	44 (77.2)	63 (84.0)	47 (81.0)	45 (83.3)
Lead apron	348 (71.3)	20 (36.4)	49 (65.3)	28 (49.1)	34 (59.6)	50 (87.7)	73 (97.3)	41 (70.7)	53 (98.1)
Lead glasses	22 (4.5)	3 (5.5)	2 (2.7)	6 (10.5)	2 (3.5)	1 (1.8)	3 (4.0)	4 (6.9)	1 (1.9)
Lead gloves	20 (4.1)	1 (1.8)	1 (1.3)	5 (8.8)	1 (1.8)	0 (0.0)	4 (5.3)	4 (6.9)	4 (7.4)
None	95 (19.5)	32 (58.2)	25 (33.3)	10 (17.5)	20 (35.1)	1 (1.8)	1 (1.3)	6 (10.3)	0 (0.0)
Not applicable	8 (1.6)	3 (5.5)	0 (0.0)	3 (5.3)	1 (1.8)	0 (0.0)	0 (0.0)	1 (1.7)	0 (0.0)
What is the shape of the intraoral radiography device's tube head at your workplace?									
Cylindrical	318 (65.2)	39 (70.9)	44 (58.7)	46 (80.7)	34 (59.6)	34 (59.6)	45 (60.0)	43 (74.1)	33 (61.1)
Rectangular	92 (18.9)	4 (7.3)	19 (25.3)	9 (15.8)	11 (19.3)	9 (15.8)	18 (24.0)	3 (5.2)	19 (35.2)
Unsure	70 (14.3)	10 (18.2)	12 (16.0)	1 (1.8)	12 (21.1)	11 (19.3)	12 (16.0)	10 (17.2)	2 (3.7)
Not applicable	8 (1.6)	2 (3.6)	0 (0.0)	1 (1.8)	0 (0.0)	3 (5.3)	0 (0.0)	2 (3.4)	0 (0.0)

(continued)

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

Table 2 (continued)

	Total participants (*N* = 488) *N* (%)	Egypt (*N* = 55) *N* (%)	Jordan (*N* = 75) *N* (%)	Mexico (*N* = 57) *N* (%)	Pakistan (*N* = 57) *N* (%)	Poland (*N* = 57) *N* (%)	Saudi Arabia (*N* = 75) *N* (%)	Türkiye (*N* = 58) *N* (%)	United States (*N* = 54) *N* (%)
Who is responsible for radiation protection in your work institution?									
Pediatric dentist	142 (29.1)	12 (21.8)	23 (30.7)	31 (54.4)	6 (10.5)	15 (26.3)	12 (16.0)	18 (31.0)	25 (46.3)
Specialist radiologist	147 (30.1)	14 (25.5)	22 (29.3)	5 (8.8)	17 (29.8)	17 (29.8)	39 (52.0)	27 (46.6)	6 (11.1)
General dentist	62 (12.7)	3 (5.5)	5 (6.7)	16 (28.1)	15 (26.3)	16 (28.1)	1 (1.3)	3 (5.2)	3 (5.6)
Other	116 (23.8)	15 (27.3)	25 (33.3)	3 (5.3)	18 (31.6)	7 (12.3)	22 (29.3)	7 (12.1)	19 (35.2)
Not applicable	21 (4.3)	11 (20.0)	0 (0.0)	2 (3.5)	1 (1.8)	2 (3.5)	1 (1.3)	3 (5.2)	1 (1.9)
Who decides on the parameters of cone-beam CT (CBCT) imaging (kVp, mA, exposure time, field of view, voxel size) in your workplace?									
The dentist who requested the scan	151 (30.9)	11 (20.0)	15 (20.0)	29 (50.9)	21 (36.8)	19 (33.3)	26 (34.7)	16 (27.6)	14 (25.9)
Another dentist working in the institution	32 (6.6)	2 (3.6)	4 (5.3)	7 (12.3)	2 (3.5)	5 (8.8)	3 (4.0)	1 (1.7)	8 (14.8)
Specialist radiologist (dentomaxillofacial radiologist or medical radiologist)	182 (37.3)	20 (36.4)	21 (28.0)	18 (31.6)	15 (26.3)	26 (45.6)	41 (54.7)	29 (50.0)	12 (22.2)
Nurse/assistant	47 (9.6)	0 (0.0)	9 (12.0)	3 (5.3)	9 (15.8)	7 (12.3)	12 (16.0)	5 (8.6)	2 (3.7)
I have no idea	104 (21.3)	21 (38.2)	20 (26.7)	11 (19.3)	11 (19.3)	9 (15.8)	12 (16.0)	11 (19.0)	9 (16.7)
Other	43 (8.8)	6 (10.9)	6 (8.0)	3 (5.3)	5 (8.8)	4 (7.0)	2 (2.7)	3 (5.2)	14 (25.9)
With their expertise, who undertakes the vital responsibility of reporting the cone-beam CT (CBCT) scan?									
The dentist who requested the scan	201 (41.2)	17 (30.9)	41 (54.7)	30 (52.6)	27 (47.4)	29 (50.9)	29 (38.7)	11 (19.0)	17 (31.5)
Another dentist working in the institution	48 (9.8)	2 (3.6)	10 (13.3)	7 (12.3)	4 (7.0)	5 (8.8)	7 (9.3)	2 (3.4)	11 (20.4)
Specialist radiologist (dentomaxillofacial radiologist or medical radiologist)	211 (43.2)	27 (49.1)	25 (33.3)	26 (45.6)	15 (26.3)	17 (29.8)	41 (54.7)	38 (65.5)	22 (40.7)
Nurse/assistant	21 (4.3)	2 (3.6)	4 (5.3)	1 (1.8)	5 (8.8)	4 (7.0)	4 (5.3)	0 (0.0)	1 (1.9)
Not reported	102 (20.9)	14 (25.5)	15 (20.0)	10 (17.5)	12 (21.1)	14 (24.6)	11 (14.7)	11 (19.0)	15 (27.8)
If you report the cone-beam CT (CBCT) images, how were you trained?									
By the company who installed the CBCT device	67 (13.7)	4 (7.3)	5 (6.7)	24 (42.1)	8 (14.0)	8 (14.0)	7 (9.3)	5 (8.6)	6 (11.1)
By the attending an independent training course on CBCT	62 (12.7)	5 (9.1)	8 (10.7)	6 (10.5)	9 (15.8)	12 (21.1)	12 (16.0)	5 (8.6)	5 (9.3)
I was not trained	280 (57.4)	36 (65.5)	54 (72.0)	23 (40.4)	34 (59.6)	29 (50.9)	38 (50.7)	33 (56.9)	33 (61.1)
Other	79 (16.2)	10 (18.2)	8 (10.7)	4 (7.0)	6 (10.5)	8 (14.0)	18 (24.0)	15 (25.9)	10 (18.5)

(continued)

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

Table 2 (continued)

	Total participants (*N* = 488) *N* (%)	Egypt (*N* = 55) *N* (%)	Jordan (*N* = 75) *N* (%)	Mexico (*N* = 57) *N* (%)	Pakistan (*N* = 57) *N* (%)	Poland (*N* = 57) *N* (%)	Saudi Arabia (*N* = 75) *N* (%)	Türkiye (*N* = 58) *N* (%)	United States (*N* = 54) *N* (%)
How many pediatric patients do you examine per week?									
<15	143 (29.3)	24 (43.6)	14 (18.7)	32 (56.1)	10 (17.5)	16 (28.1)	27 (36.0)	14 (24.1)	6 (11.1)
15-25	134 (27.5)	13 (23.6)	23 (30.7)	18 (31.6)	24 (42.1)	12 (21.1)	21 (28.0)	15 (25.9)	8 (14.8)
25-35	86 (17.6)	4 (7.3)	17 (22.7)	4 (7.0)	15 (26.3)	9 (15.8)	18 (24.0)	10 (17.2)	9 (16.7)
35-45	41 (8.4)	7 (12.7)	8 (10.7)	2 (3.5)	3 (5.3)	6 (10.5)	5 (6.7)	4 (6.9)	6 (11.1)
>45	84 (17.2)	7 (12.7)	13 (17.3)	1 (1.8)	5 (8.8)	14 (24.6)	4 (5.3)	15 (25.9)	25 (46.3)
How many intraoral radiographs (periapical, bitewing, occlusal, etc) are taken per week from your patients?									
<10	216 (44.4)	28 (50.9)	48 (64.0)	33 (57.9)	8 (14.0)	40 (70.2)	27 (36.0)	29 (50.0)	3 (5.6)
10-20	131 (26.8)	16 (29.1)	20 (26.7)	17 (29.8)	14 (24.6)	12 (21.1)	30 (40.0)	18 (31.0)	4 (7.4)
20-30	64 (13.1)	5 (9.1)	3 (4.0)	5 (8.8)	20 (35.1)	3 (5.3)	12 (16.0)	6 (10.3)	10 (18.5)
30-40	27 (5.5)	1 (1.8)	3 (4.0)	2 (3.5)	6 (10.5)	1 (1.8)	3 (4.0)	1 (1.7)	10 (18.5)
>40	50 (10.2)	5 (9.1)	1 (1.3)	0 (0.0)	9 (15.8)	1 (1.8)	3 (4.0)	4 (6.9)	27 (50.0)
How many extraoral radiographs (panoramic radiographs, lateral cephalograms, etc) are taken per week from your patients?									
<10	314 (64.4)	35 (63.6)	55 (73.3)	48 (84.2)	35 (61.4)	43 (75.4)	57 (76.0)	18 (31.0)	23 (42.6)
10-20	101 (20.7)	14 (25.5)	11 (14.7)	5 (8.8)	15 (26.3)	11 (19.3)	12 (16.0)	16 (27.6)	17 (31.5)
20-30	45 (9.2)	2 (3.6)	9 (12.0)	3 (5.3)	2 (3.5)	3 (5.3)	5 (6.7)	13 (22.4)	8 (14.8)
30-40	10 (2.0)	1 (1.8)	0 (0.0)	1 (1.8)	3 (5.3)	0 (0.0)	0 (0.0)	2 (3.4)	3 (5.6)
>40	18 (3.7)	3 (5.5)	0 (0.0)	0 (0.0)	2 (3.5)	0 (0.0)	1 (1.3)	9 (15.5)	3 (5.6)
How many cone-beam CT (CBCT) or CT imaging are taken per month from your patients?									
<5	444 (91.0)	53 (96.4)	72 (96.0)	49 (86.0)	51 (89.5)	48 (84.2)	72 (96.0)	49 (84.5)	50 (92.6)
5-10	19 (3.9)	2 (3.6)	1 (1.3)	4 (7.0)	2 (3.5)	4 (7.0)	1 (1.3)	4 (6.9)	1 (1.9)
10-15	14 (2.9)	0 (0.0)	0 (0.0)	1 (1.8)	2 (3.5)	3 (5.3)	2 (2.7)	4 (6.9)	2 (3.7)
15-20	6 (1.2)	0 (0.0)	0 (0.0)	3 (5.3)	1 (1.8)	2 (3.5)	0 (0.0)	0 (0.0)	0 (0.0)
>20	5 (1.0)	0 (0.0)	2 (2.7)	0 (0.0)	1 (1.8)	0 (0.0)	0 (0.0)	1 (1.7)	1 (1.9)
Are radiation exposure parameters adjusted in accordance with the patient's characteristics during intraoral imaging in your workplace?									
No	74 (15.1)	6 (10.9)	17 (22.7)	9 (15.8)	9 (15.8)	3 (5.3)	10 (13.3)	8 (13.8)	12 (22.2)
Yes	275 (56.4)	24 (43.6)	58 (77.3)	33 (57.9)	25 (43.9)	34 (59.6)	42 (56.0)	30 (51.7)	29 (53.7)
Not sure	122 (25.0)	20 (36.4)	0 (0.0)	13 (22.8)	23 (40.4)	17 (29.8)	21 (28.0)	15 (25.9)	13 (24.1)
Not applicable	17 (3.5)	5 (9.1)	0 (0.0)	2 (3.5)	0 (0.0)	3 (5.3)	2 (2.7)	5 (8.6)	0 (0.0)

(continued)

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

Table 2 (continued)

	Total participants (*N* = 488) *N* (%)	Egypt (*N* = 55) *N* (%)	Jordan (*N* = 75) *N* (%)	Mexico (*N* = 57) *N* (%)	Pakistan (*N* = 57) *N* (%)	Poland (*N* = 57) *N* (%)	Saudi Arabia (*N* = 75) *N* (%)	Türkiye (*N* = 58) *N* (%)	United States (*N* = 54) *N* (%)
Which radiography technique do you independently perform?									
Intraoral radiography	411 (84.2)	52 (94.5)	66 (88.0)	51 (89.5)	45 (78.9)	43 (75.4)	63 (84.0)	47 (81.0)	44 (81.5)
Hand-held intraoral radiography	160 (32.8)	29 (52.7)	23 (30.7)	11 (19.3)	24 (42.1)	9 (15.8)	22 (29.3)	8 (13.8)	34 (63.0)
Extraoral radiography	173 (35.5)	6 (10.9)	29 (38.7)	23 (40.4)	9 (15.8)	33 (57.9)	20 (26.7)	23 (39.7)	30 (55.6)
Cone-beam CT (CBCT)	36 (7.4)	0 (0.0)	0 (0.0)	6 (10.5)	2 (3.5)	12 (21.1)	4 (5.3)	9 (15.5)	3 (5.6)
Other	5 (1.0)	1 (1.8)	0 (0.0)	2 (3.5)	1 (1.8)	0 (0.0)	1 (1.3)	0 (0.0)	0 (0.0)
None	56 (11.5)	3 (5.5)	6 (8.0)	1 (1.8)	9 (15.8)	10 (17.5)	10 (13.3)	7 (12.1)	10 (18.5)
Which radiography technique does your nurse/assistant/technician independently perform?									
Intraoral radiography	315 (64.5)	25 (45.5)	34 (45.3)	49 (86.0)	52 (91.2)	20 (35.1)	54 (72.0)	29 (50.0)	52 (96.3)
Hand-held intraoral radiography	154 (31.6)	16 (29.1)	18 (24.0)	11 (19.3)	33 (57.9)	7 (12.3)	21 (28.0)	6 (10.3)	42 (77.8)
Extraoral radiography	270 (55.3)	20 (36.4)	44 (58.7)	13 (22.8)	25 (43.9)	32 (56.1)	43 (57.3)	45 (77.6)	48 (88.9)
Cone-beam CT (CBCT)	114 (23.4)	5 (9.1)	13 (17.3)	4 (7.0)	11 (19.3)	24 (42.1)	23 (30.7)	24 (41.4)	10 (18.5)
Other	3 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.8)	0 (0.0)	2 (2.7)	0 (0.0)	0 (0.0)
None	82 (16.8)	20 (36.4)	17 (22.7)	5 (8.8)	2 (3.5)	19 (33.3)	10 (13.3)	7 (12.1)	2 (3.7)
Which radiation protection equipment do you employ on the patient during intraoral imaging procedures, including periapical, bitewing, and occlusal imaging?									
Thyroid shield	231 (47.3)	8 (14.5)	17 (22.7)	31 (54.4)	8 (14.0)	37 (64.9)	56 (74.7)	33 (56.9)	41 (75.9)
Lead apron	264 (54.1)	16 (29.1)	30 (40.0)	29 (50.9)	17 (29.8)	46 (80.7)	63 (84.0)	18 (31.0)	45 (83.3)
Lead glasses	236 (48.4)	16 (29.1)	2 (2.7)	29 (50.9)	17 (29.8)	46 (80.7)	63 (84.0)	18 (31.0)	45 (83.3)
Lead gloves	235 (48.2)	16 (29.1)	1 (1.3)	29 (50.9)	17 (29.8)	46 (80.7)	63 (84.0)	18 (31.0)	45 (83.3)
None	157 (32.2)	37 (67.3)	44 (58.7)	12 (21.1)	33 (57.9)	2 (3.5)	3 (4.0)	22 (37.9)	4 (7.4)
Not applicable	14 (2.9)	3 (5.5)	0 (0.0)	3 (5.3)	3 (5.3)	2 (3.5)	0 (0.0)	3 (5.2)	0 (0.0)
Which radiation protection equipment do you employ on the patient during extraoral imaging procedures, including panoramic radiographs and lateral cephalograms?									
Thyroid shield	200 (41.0)	11 (20.0)	17 (22.7)	27 (47.4)	10 (17.5)	28 (49.1)	49 (65.3)	29 (50.0)	29 (53.7)
Lead apron	297 (60.9)	22 (40.0)	30 (40.0)	30 (52.6)	20 (35.1)	49 (86.0)	68 (90.7)	34 (58.6)	44 (81.5)
Lead glasses	269 (55.1)	22 (40.0)	2 (2.7)	30 (52.6)	20 (35.1)	49 (86.0)	68 (90.7)	34 (58.6)	44 (81.5)
Lead gloves	268 (54.9)	22 (40.0)	1 (1.3)	30 (52.6)	20 (35.1)	49 (86.0)	68 (90.7)	34 (58.6)	44 (81.5)
None	143 (29.3)	27 (49.1)	44 (58.7)	12 (21.1)	30 (52.6)	1 (1.8)	5 (6.7)	18 (31.0)	6 (11.1)
Not applicable	22 (4.5)	8 (14.5)	0 (0.0)	7 (12.3)	3 (5.3)	2 (3.5)	0 (0.0)	1 (1.7)	1 (1.9)

(continued)

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

Table 2 (continued)

	Total participants (*N* = 488) *N* (%)	Egypt (*N* = 55) *N* (%)	Jordan (*N* = 75) *N* (%)	Mexico (*N* = 57) *N* (%)	Pakistan (*N* = 57) *N* (%)	Poland (*N* = 57) *N* (%)	Saudi Arabia (*N* = 75) *N* (%)	Türkiye (*N* = 58) *N* (%)	United States (*N* = 54) *N* (%)
Which radiation protective equipment do you employ on patients during cone-beam CT (CBCT) imaging procedures?									
Thyroid shield	196 (40.2)	13 (23.6)	32 (42.7)	23 (40.4)	8 (14.0)	26 (45.6)	49 (65.3)	26 (44.8)	19 (35.2)
Lead apron	269 (55.1)	20 (36.4)	33 (44.0)	21 (36.8)	23 (40.4)	44 (77.2)	64 (85.3)	34 (58.6)	30 (55.6)
Lead glasses	242 (49.6)	20 (36.4)	6 (8.0)	21 (36.8)	23 (40.4)	44 (77.2)	64 (85.3)	34 (58.6)	30 (55.6)
Lead gloves	238 (48.8)	20 (36.4)	2 (2.7)	21 (36.8)	23 (40.4)	44 (77.2)	64 (85.3)	34 (58.6)	30 (55.6)
None	134 (27.5)	26 (47.3)	35 (46.7)	15 (26.3)	30 (52.6)	0 (0.0)	5 (6.7)	13 (22.4)	10 (18.5)
Not applicable	54 (11.1)	9 (16.4)	0 (0.0)	14 (24.6)	2 (3.5)	10 (17.5)	0 (0.0)	7 (12.1)	12 (22.2)
What method/s is/are used to position the film/sensor during intraoral imaging in your practice?									
Receptor holder	228 (46.7)	17 (30.9)	0 (0.0)	34 (59.6)	23 (40.4)	43 (75.4)	53 (70.7)	7 (12.1)	51 (94.4)
Patient's/accompanying person's finger	195 (40.0)	23 (41.8)	26 (34.7)	18 (31.6)	18 (31.6)	30 (52.6)	29 (38.7)	40 (69.0)	11 (20.4)
Performer's finger	236 (48.4)	32 (58.2)	51 (68.0)	21 (36.8)	26 (45.6)	27 (47.4)	33 (44.0)	29 (50.0)	17 (31.5)
Unsure	45 (9.2)	3 (5.5)	12 (16.0)	5 (8.8)	10 (17.5)	3 (5.3)	7 (9.3)	3 (5.2)	2 (3.7)
Not applicable	14 (2.9)	3 (5.5)	0 (0.0)	5 (8.8)	1 (1.8)	1 (1.8)	1 (1.3)	3 (5.2)	0 (0.0)
Which type of radiographic imaging/film is most commonly used for intraoral imaging in your practice?									
Conventional film D-speed	28 (5.7)	6 (10.9)	2 (2.7)	9 (15.8)	4 (7.0)	2 (3.5)	4 (5.3)	1 (1.7)	0 (0.0)
Conventional film E-speed	31 (6.4)	7 (12.7)	2 (2.7)	10 (17.5)	3 (5.3)	1 (1.8)	2 (2.7)	4 (6.9)	2 (3.7)
Conventional film F-speed	15 (3.1)	4 (7.3)	3 (4.0)	3 (5.3)	1 (1.8)	0 (0.0)	0 (0.0)	2 (3.4)	2 (3.7)
Digital storage phosphor plate	94 (19.3)	1 (1.8)	11 (14.7)	5 (8.8)	11 (19.3)	13 (22.8)	16 (21.3)	30 (51.7)	7 (13.0)
Digital charged coupled device sensor	181 (37.1)	17 (30.9)	37 (49.3)	19 (33.3)	8 (14.0)	24 (42.1)	35 (46.7)	5 (8.6)	36 (66.7)
I have no idea.	129 (26.4)	16 (29.1)	20 (26.7)	9 (15.8)	30 (52.6)	15 (26.3)	17 (22.7)	15 (25.9)	7 (13.0)
Not applicable	10 (2.0)	4 (7.3)	0 (0.0)	2 (3.5)	0 (0.0)	2 (3.5)	1 (1.3)	1 (1.7)	0 (0.0)
Which field of view (FOV) size do you most frequently prefer for cone-beam CT (CBCT) images in your practice?									
Partial jaw	158 (32.5)	25 (45.5)	23 (30.7)	10 (17.5)	10 (17.5)	33 (57.9)	20 (26.7)	28 (48.3)	9 (16.7)
Full jaw	47 (9.6)	1 (1.8)	7 (9.3)	9 (15.8)	5 (8.8)	6 (10.5)	7 (9.3)	7 (12.1)	5 (9.3)
Both jaws	60 (12.3)	2 (3.6)	3 (4.0)	17 (29.8)	14 (24.6)	7 (12.3)	7 (9.3)	5 (8.6)	5 (9.3)
Large	10 (2.0)	0 (0.0)	0 (0.0)	1 (1.8)	2 (3.5)	2 (3.5)	2 (2.7)	3 (5.2)	0 (0.0)
Unsure	213 (43.6)	27 (49.1)	42 (56.0)	20 (35.1)	26 (45.6)	9 (15.8)	39 (52.0)	15 (25.9)	35 (64.8)

N: number. For multiple-response questions, participants were allowed to select more than one option; therefore, the sum of percentages may exceed 100%.

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

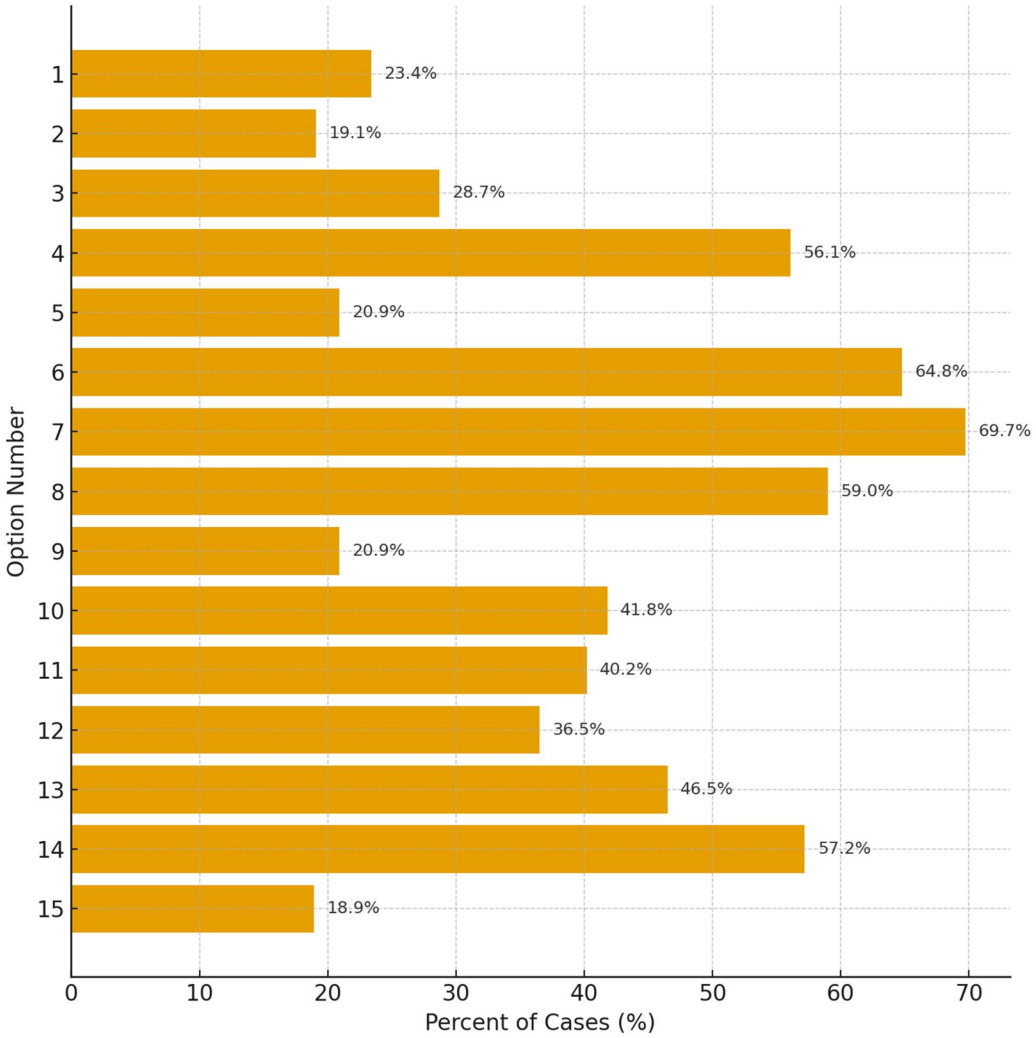


Figure 3 Indications for which participants prefer periapical radiography as the first choice in pediatric patients. (Options 1-15 correspond to: caries detection and diagnosis (1), acute dental infection (2), tooth fractures and luxation injuries (3), severe dental trauma: multiple fractured teeth, crown-root fractures, mobile fragments etc (4), tooth resorption due to dental trauma (5), hypodontia (6), supernumerary teeth (7), suspected tooth impaction (8), molar incisor hypomineralization (9), amelogenesis/dentinogenesis/osteogenesis imperfecta (10), cleft lip and palate patients (11), periodontal disease (12), condylar morphology in patients with temporomandibular dysfunction (13), cyst and benign tumors (14), invasive cervical resorption (15)).

protection measures. Several surveys also reported that many clinicians rely on perceived rather than evidence-based competence, often in the absence of formal education on radiation biology and pediatric-specific exposure risks.[21,23] The similarity between these findings and the present results may suggest that the challenges identified in pediatric dental imaging are, at least in part, influenced by broader systemic limitations in radiographic education across dentistry. In particular, the reliance on perceived rather than evidence-based competence may help explain the discrepancy observed in our data between the classification of "moderate" knowledge and only partial adherence to recommended practices. Accordingly, this apparent discrepancy should be interpreted with caution, as the categorization of knowledge levels reflects performance within the context of the study instrument and may also be influenced by clinical and institutional factors, rather than representing a purely context-independent measure of theoretical knowledge.

In comparison with previous studies reporting pronounced deficiencies in dentists' radiographic knowledge, the pediatric dentists in the current multinational cohort demonstrated a more favorable overall profile. Notably, awareness of radiation protection principles appeared higher than that reported in studies from Jordan,[25] Türkiye,[21] and Palestine,[24] where implementation and interpretation of basic protection measures were frequently inconsistent. This relatively improved profile may reflect the stronger emphasis placed on radiation safety within pediatric dentistry training, where patient vulnerability necessitates increased attention to dose considerations. Nevertheless, the variation in knowledge scores observed between countries in our sample echoes earlier findings from the United States[26] and Lithuania,[17] suggesting that disparities in training quality, access to structured radiology education, and continuing professional development persist across settings. These cross-country differences further support the interpretation that radiographic decision-making is influenced by systemic

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

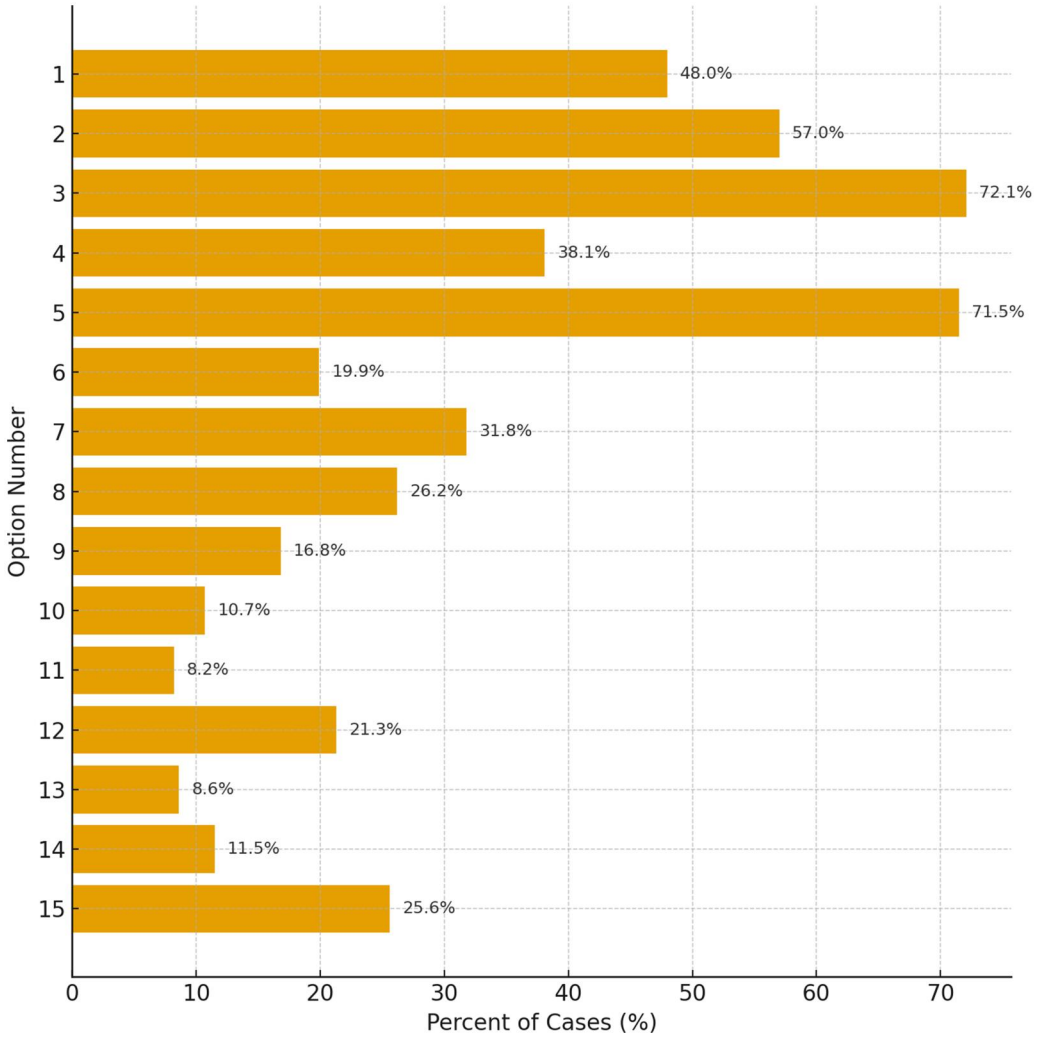


Figure 4 Indications for which participants prefer panoramic radiography as the first choice in pediatric patients. (Options 1-15 correspond to: caries detection and diagnosis (1), acute dental infection (2), tooth fractures and luxation injuries (3), severe dental trauma: multiple fractured teeth, crown-root fractures, mobile fragments etc (4), tooth resorption due to dental trauma (5), hypodontia (6), supernumerary teeth (7), suspected tooth impaction (8), molar incisor hypomineralization (9), amelogenesis/dentinogenesis/osteogenesis imperfecta (10), cleft lip and palate patients (11), periodontal disease (12), condylar morphology in patients with temporomandibular dysfunction (13), cyst and benign tumors (14), invasive cervical resorption (15)).

and educational factors rather than solely by individual-level knowledge.

Comparison of participants' radiographic preferences with EAPD recommendations revealed patterns partially consistent with guideline frameworks, alongside several notable discrepancies. Periapical radiography was appropriately preferred for localized developmental anomalies such as supernumerary teeth, hypodontia, and suspected impaction, for which EAPD recommends it as the first-line modality.[11] However, periapical radiographs were selected less frequently for trauma-related situations (eg, root resorption, crown-root fractures) and for single severely affected hypomineralized molars, despite these being explicitly listed as periapical indications in the guideline.[11] Conversely, panoramic radiography was most often chosen for acute trauma and infection, although EAPD does not recommend panoramic imaging as a first-line modality in such cases.[11] This pattern suggests a tendency among clinicians to favor broader FOV imaging in diagnostically uncertain or urgent situations, potentially driven by perceived diagnostic convenience, time efficiency, and challenges in obtaining intraoral radiographs in pediatric patients. A previous systematic review has reported limited scientific evidence supporting routine panoramic imaging in children and adolescents and recommended avoiding its use for primary dentition, caries diagnosis, acute dental infections, and dental trauma, while reserving it for craniofacial trauma, dental anomalies, developmental disorders, and pathological conditions.[27] These recommendations provide important context for interpreting the present findings and suggest that deviations from guideline-based modality selection may reflect both uncertainty in applying recommendations and practical considerations inherent to pediatric care.

Guideline-based evaluation of CBCT use further highlighted gaps between recommended and actual clinical practice. According to EAPD,[11] CBCT should be reserved for specific

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

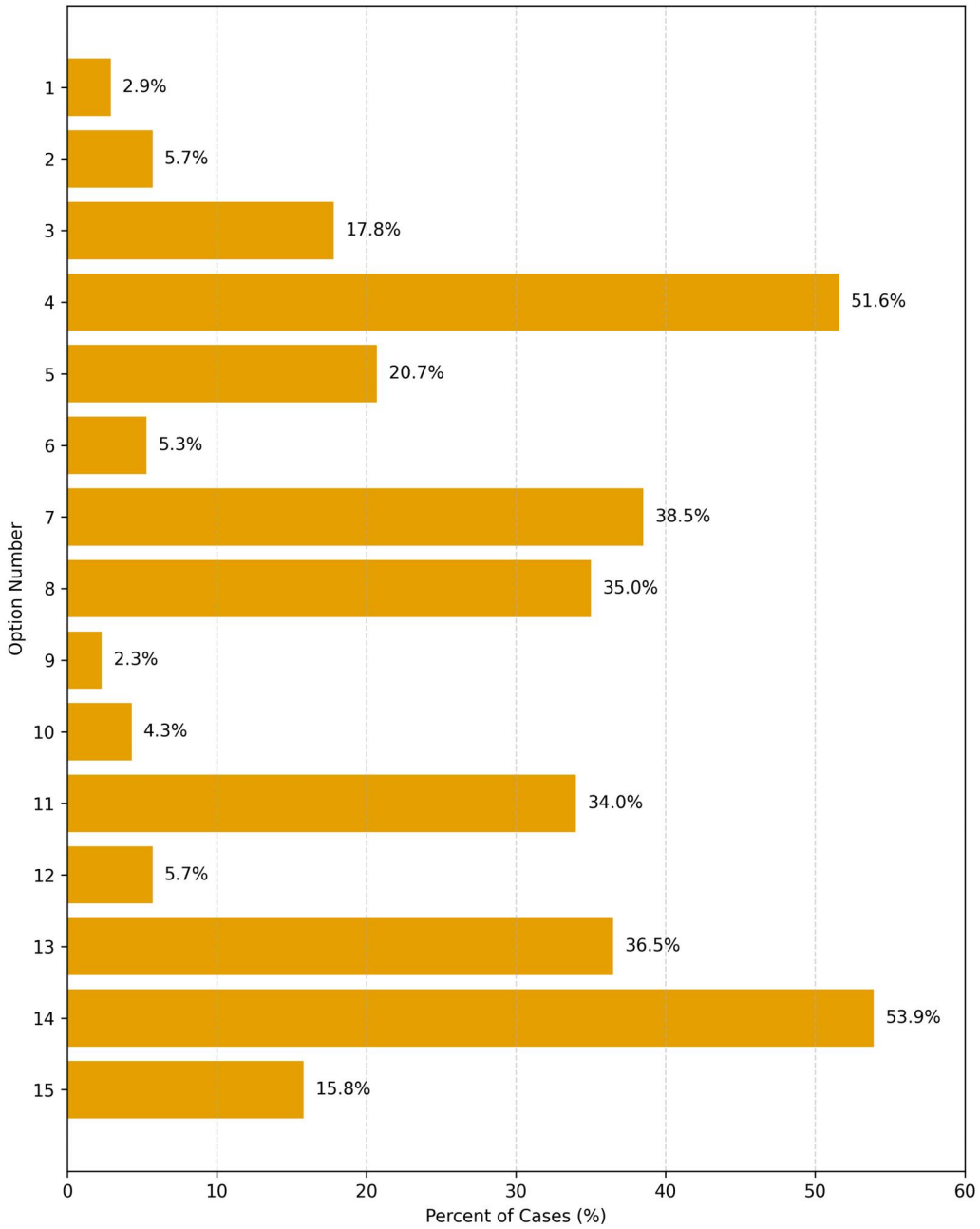


Figure 5 Most common indications for cone-beam computed tomography (CBCT) in pediatric patients. (Options 1-15 correspond to: caries detection and diagnosis (1), acute dental infection (2), tooth fractures and luxation injuries (3), severe dental trauma: multiple fractured teeth, crown-root fractures, mobile fragments etc. (4), tooth resorption due to dental trauma (5), hypodontia (6), supernumerary teeth (7), suspected tooth impaction (8), molar incisor hypomineralization (9), amelogenesis/dentinogenesis/osteogenesis imperfecta (10), cleft lip and palate patients (11), periodontal disease (12), condylar morphology in patients with temporomandibular dysfunction (13), cyst and benign tumors (14), invasive cervical resorption (15)).

conditions such as severe dental trauma, trauma-related root resorption, amelogenesis/dentinogenesis/osteogenesis imperfecta, cleft lip and palate, cysts and benign tumors, and invasive cervical resorption. Clinical research in pediatric patients remains limited, particularly at higher levels of diagnostic efficacy, and evidence specific to pediatric populations remains insufficient.[13] Complementing these recommendations, the DIMITRA project[4] provides detailed guidance regarding image resolution and FOV selection for different clinical conditions. However, the present findings suggest that these structured recommendations are not consistently translated into practice, likely due to the technical complexity of CBCT protocols, variability in access to technology, and limited exposure to formal training. Participants' knowledge of resolution- and indication-specific recommendations was limited: mean correct scores were only 5.9 out of 10 for low-resolution scenarios and 3.7 out of 10 for high-resolution scenarios, indicating that more nuanced guideline-based parameters—such as selecting the minimum necessary resolution or restricting high-resolution scans to cases with clear diagnostic benefit—are not well understood. These knowledge limitations were mirrored

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

in self-reported behaviors: 57.4% of participants who interpret CBCT scans reported having received no formal training and 43.6% were uncertain about appropriate FOV selection. This limited clinical exposure likely reduces opportunities for skill development, reinforcing uncertainty in CBCT-related decision-making. Together, these findings suggest that deficiencies in CBCT use reflect not only informational gaps but also insufficient structured training, limited hands-on experience, and the inherent technical complexity of CBCT protocols.

Radiation protection knowledge and implementation exhibited a mixed pattern, consistent with findings reported in previous studies from Europe,[14,28] the United States,[19,26] and Asia.[24,25] Although basic protective equipment was widely available, awareness and implementation of key dose-reduction strategies—particularly rectangular collimation and optimization of exposure parameters—remained limited. Only 41.6% of participants identified rectangular collimation as the most effective radiation protection measure, and fewer than 1 in 5 recognized its impact on dose reduction. Similarly, only 39.0% correctly identified the most dose-efficient intraoral receptor, and just 7.3% knew which device parameter most strongly affects patient dose. This discrepancy between equipment availability and knowledge of optimization principles suggests that access to equipment alone does not ensure appropriate use and highlights the need for a more principle-driven approach to radiation protection.

Furthermore, evolving and sometimes conflicting recommendations regarding patient shielding may contribute to variability in clinical practice. While earlier guidelines emphasized protective equipment, more recent evidence questions its routine use due to low radiation doses and potential interference with image quality.[2,29] At the same time, some recent evidence-based reviews continue to support thyroid shielding, particularly in pediatric CBCT imaging.[30,31] This lack of consensus may contribute to uncertainty among clinicians and reinforce reliance on traditional practices rather than updated, evidence-based approaches.

Importantly, the relatively consistent knowledge levels observed across countries suggest that these challenges are not confined to specific regions but reflect broader systemic issues. Differences in training pathways, access to imaging technologies, and continuing professional development opportunities likely contribute to variability; however, the overall pattern indicates that similar barriers exist across diverse healthcare systems.

From a clinical and educational perspective, these findings highlight the need to move beyond knowledge dissemination toward more effective strategies that support the translation of guideline-based principles into practice. Structured, practice-oriented training approaches—such as case-based learning, hands-on CBCT training, and integration of decision-support tools—may be particularly valuable in bridging this gap.

This study has several strengths, including its large sample size, multinational scope, and comprehensive evaluation of both knowledge and clinical practices. The inclusion of guideline-referenced questions enhances the clinical relevance of the findings and allows meaningful comparison with international standards. Several limitations should be acknowledged. The cross-sectional design precludes causal inference, and self-reported responses may not fully reflect actual clinical behavior. The use of a convenience and snowball sampling strategy introduces potential selection, coverage, and non-response bias, as previously described,[32] and may limit the generalizability of the findings. In addition, recruitment through heterogeneous channels—including national professional associations, academic mailing lists, social media groups, and personal networks—may have resulted in uneven coverage across settings, as not all eligible pediatric dentists may have been reachable through these sources, and the completeness and currency of these channels could not be systematically verified. The voluntary and anonymous nature of participation also introduces methodological constraints, including the inability to assess non-responders and a potential risk of duplicate submissions, as unique responses could not be formally verified. Although no incentives were provided and no response patterns suggestive of duplication were identified, this possibility cannot be entirely excluded. In addition, the multinational design introduces heterogeneity in training systems, regulatory frameworks, and resource availability, which were not directly analyzed and may have influenced the observed patterns. Importantly, some responses—particularly those related to clinical practices—may reflect the combined influence of institutional constraints and infrastructural availability rather than knowledge alone. Accordingly, the knowledge levels reported in this study should be interpreted with caution, as they likely represent a composite of theoretical understanding, clinical experience, and contextual factors, rather than an isolated measure of knowledge. Furthermore, as data were pooled across countries primarily to identify overarching patterns, potential country-specific differences may have been obscured, and the included countries should not be considered representative of all settings with specialist pediatric dental practice. Moreover, international guideline frameworks may not be uniformly implemented or enforced across participating countries, and thus some observed differences may reflect variation in national regulatory contexts rather than true differences in professional knowledge.

Taken together, the findings of this multinational survey indicate that pediatric dentists demonstrate moderate knowledge levels regarding dentomaxillofacial imaging; however, important gaps remain in the consistent application of guideline-based principles. The observed variability reflects a complex interplay between knowledge, clinical experience, and contextual factors, rather than a simple deficiency in theoretical understanding. Addressing these challenges will require a shift toward competency-based education, improved integration of guidelines into clinical workflows, and continued efforts to support evidence-based radiographic decision-making in pediatric dentistry. Future research may further benefit from methodological refinements, such as the use of more structured sampling strategies, including random or registry-based approaches where feasible, as well as survey designs that allow follow-up contact and facilitate a more detailed evaluation of response patterns. In addition, incorporating multivariable analytical approaches could provide further insight into whether observed differences are independently associated with country or reflect other factors such as professional experience, practice setting, or prior radiology training.

Conclusion

This multinational survey demonstrates that, although pediatric dentists generally exhibit moderate knowledge levels regarding dentomaxillofacial imaging, important gaps remain in the

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

implementation of radiation-protection principles and guideline-based decision-making. While indication selection was largely consistent with international recommendations, knowledge and application of dose-optimization strategies—particularly ALARA/ALADAIP principles, rectangular collimation, individualized exposure settings, and CBCT parameter selection—were inconsistent. These findings suggest that awareness of guidelines does not necessarily translate into their effective application in clinical practice, highlighting a persistent knowledge-practice gap.

The relatively homogeneous distribution of knowledge across countries, despite differences in healthcare systems and training environments, indicates that these challenges are likely systemic rather than context-specific. This underscores the need for a shift from knowledge-focused education toward competency-based, practice-oriented training that facilitates the translation of theoretical principles into clinical behavior. Strengthening pediatric-specific radiology curricula, expanding access to structured continuing education, and reinforcing guideline implementation through institutional policies and quality assurance mechanisms will be essential to improving radiation safety. Ultimately, optimizing pediatric dental imaging requires not only adherence to evidence-based recommendations but also the development of practical competencies that ensure radiation exposure is minimized while maintaining diagnostic efficacy, thereby supporting safer and more effective patient care.

Acknowledgements

The authors would like to thank all pediatric dentists who participated in this study.

Author contributions

Conceptualization: Berkant Sezer, Gamze Coşan Ata; Methodology: Berkant Sezer, Gamze Coşan Ata, Canan Duman, Hakan Eren; Formal analysis and investigation: Berkant Sezer, Gamze Coşan Ata, Canan Duman, Hakan Eren, Ola B. Al-Batayneh, Yousef Khader, Heba Sabbagh, Sajjad Ahmad, Angelika Kobylińska, Alvaro García Pérez, Marwa Baraka, Majd Alsaleh; Writing—original draft preparation: Berkant Sezer; Writing—review and editing: Berkant Sezer, Gamze Coşan Ata, Ola B. Al-Batayneh, Alvaro García Pérez, Marwa Baraka, Majd Alsaleh; Supervision: Berkant Sezer, Hakan Eren.

Supplementary material

Supplementary material is available at *Dentomaxillofacial Radiology* online.

Conflicts of interest

The authors declare no conflict of interest.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

1. Firetto MC, Abbinante A, Barbato E, et al. National guidelines for dental diagnostic imaging in the developmental age. *Radiol Med*. 2019;124:887-916. https://doi.org/10.1007/s11547-019-01038-4
2. *Prescribing Dental Radiographs for İnfants, Children, Adolescents, and İndividuals with Special Health Care Needs. The Reference Manual of Pediatric Dentistry*. American Academy of Pediatric Dentistry; 2025:332-336.
3. White SC, Scarfe WC, Schulze RK, et al. The Image Gently in Dentistry campaign: promotion of responsible use of maxillofacial radiology in dentistry for children. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2014;118:257-261. https://doi.org/10.1016/j.oooo.2014.06.001
4. Oenning AC, Jacobs R, Pauwels R, et al.; DIMITRA Research Group. Cone-beam CT in paediatric dentistry: DIMITRA project position statement. *Pediatr Radiol*. 2018;48:308-316. https://doi.org/10.1007/s00247-017-4012-9
5. Schüler IM, Hennig CL, Buschek R, et al. Radiation exposure and frequency of dental, bitewing and occlusal radiographs in children and adolescents. *J Pers Med*. 2023;13:692. https://doi.org/10.3390/jpm13040692
6. Hennig CL, Schüler IM, Scherbaum R, et al. Frequency of dental X-ray diagnostics in children and adolescents: what is the radiation exposure? *Diagnostics (Basel)*. 2023;13:394. https://doi.org/10.3390/diagnostics13030394
7. Hedesiu M, Marcu M, Salmon B, et al.; DIMITRA Research Group. Irradiation provided by dental radiological procedures in a pediatric population. *Eur J Radiol*. 2018;103:112-117. https://doi.org/10.1016/j.ejrad.2018.04.021
8. De Felice F, Di Carlo G, Saccucci M, Tombolini V, Polimeni A. Dental cone beam computed tomography in children: clinical effectiveness and cancer risk due to radiation exposure. *Oncology*. 2019;96:173-178. https://doi.org/10.1159/000497059
9. Jacobs R, Pauwels R, Scarfe WC, et al. Pediatric cleft palate patients show a 3- to 5-fold increase in cumulative radiation exposure from dental radiology compared with an age- and gender-matched population: a retrospective cohort study. *Clin Oral Investig*. 2018;22:1783-1793. https://doi.org/10.1007/s00784-017-2274-0
10. Angelieri F, de Oliveira GR, Sannomiya EK, Ribeiro DA. DNA damage and cellular death in oral mucosa cells of children who have undergone panoramic dental radiography. *Pediatr Radiol*. 2007;37:561-565. https://doi.org/10.1007/s00247-007-0478-1
11. Kühnisch J, Anttonen V, Duggal MS, et al. Best clinical practice guidance for prescribing dental radiographs in children and adolescents: an EAPD policy document. *Eur Arch Paediatr Dent*. 2020;21:375-386. https://doi.org/10.1007/s40368-019-00493-x
12. Oenning AC, Jacobs R, Salmon B; DIMITRA Research Group. ALADAIP, beyond ALARA and towards personalized optimization for paediatric cone-beam CT. *Int J Paediatr Dent*. 2021;31:676-678. https://doi.org/10.1111/ipd.12797
13. Horner K, Barry S, Dave M, et al. Diagnostic efficacy of cone beam computed tomography in paediatric dentistry: a systematic review. *Eur Arch Paediatr Dent*. 2020;21:407-426. https://doi.org/10.1007/s40368-019-00504-x

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026

14. Mitsea A, Seremidi K, Christoloukas N, Gizani S. Exposure and protection protocols of dentomaxillofacial imaging applied by paediatric dentists in Europe. *Oral Radiol*. 2024;40:188-198. https://doi.org/10.1007/s11282-023-00720-8
15. The reference manual of pediatric dentistry. Prescribing dental radiographs for ınfants, children, adolescents, and ındividuals with special health care needs. *Pediatr Dent*. 2018;40:213-215.
16. Giray FE, Peker S, Yalcinkaya SE, Kargul B, Aps J. Attitudes and knowledge of paediatric dentists' on digital radiography and cone beam computed tomography. *J Pak Med Assoc*. 2019;69:205-210.
17. Masyte V, Sefeldaite S, Venskutonis T. A Questionnaire of digital radiography and CBCT use and knowledge among lithuanian dentists. *J Oral Maxillofac Res*. 2021;12:e2. https://doi.org/10.5037/jomr.2021.12102
18. Rahman FBA, Gurunathan D, Vasantharajan MS. Knowledge, attitude and practice of radiation exposure protection for pediatric patients among undergraduate dental students. *Biomed Pharmacol J*. 2018;11:1143-1151.
19. Campbell RE, Wilson S, Zhang Y, Scarfe WC. A survey on radiation exposure reduction methods including rectangular collimation for intraoral radiography by pediatric dentists in the United States. *J Am Dent Assoc*. 2020;151:287-296. https://doi.org/10.1016/j.adaj.2020.01.014
20. Bhardwaj SS, Alghamdi S, Almulhim B, et al. CBCT in pediatric dentistry: awareness and knowledge of its correct use in Saudi Arabia. *Appl Sci*. 2022;12:335. https://doi.org/10.3390/app12010335
21. Coşkun Albayrak S, Özdemir ÖS. Awareness of cone beam computed tomography (CBCT) use and radiation safety among dentists and specialists. *BMC Oral Health*. 2025;25:1436. https://doi.org/10.1186/s12903-025-06754-0
22. Uvarichev M, Sherstneva V, Mikheikina A, et al. CBCT: knowledge, attitude, and practice among dentists. *BMC Oral Health*. 2025;25:1540. https://doi.org/10.1186/s12903-025-06870-x
23. Abdalla-Aslan R, Almoznino G, Moskovich L, Aframian DJ, Nadler C. Knowledge and responsibility in CBCT practice among general and specialized Israeli dentists—a questionnaire based study. *BMC Oral Health*. 2025;25:291. https://doi.org/10.1186/s12903-025-05429-0
24. Aljamal M, Batakat T, Hamd Z, Abuzaid M, Gareeballah A. Evaluating radiation safety knowledge and practices in dental professionals: findings from a cross-sectional survey. *BMC Med Educ*. 2025;25:973. https://doi.org/10.1186/s12909-025-07554-4
25. Alshbool BD, Alzoubi MM, Ajwa NM, et al. Assessment of knowledge, availability, and practice of interventional radiation safety among dental professionals: a cross-sectional study. *Medicine (Baltimore)*. 2025;104:e44877. https://doi.org/10.1097/MD.0000000000044877
26. Lintag K, Bruhn AM, Tolle SL, Diawara N. Radiation safety practices of dental hygienists in the United States. *J Dent Hyg*. 2019;93:14-23.
27. Tsiklakis K, Mitsea A, Tsichlaki A, Pandis N. A systematic review of relative indications and contra-indications for prescribing panoramic radiographs in dental paediatric patients. *Eur Arch Paediatr Dent*. 2020;21:387-406. https://doi.org/10.1007/s40368-019-00478-w
28. Gizani S, Seremidi K, Gkourtsogianni S, Mitsea A. Awareness and practice of dentomaxillofacial imaging among paediatric dentists: a questionnaire survey of members of the European Academy of Paediatric Dentistry. *Oral Radiol*. 2023;39:576-587. https://doi.org/10.1007/s11282-023-00675-w
29. Benavides E, Bhula A, Gohel A, et al. Patient shielding during dentomaxillofacial radiography: recommendations from the American Academy of Oral and Maxillofacial Radiology. *J Am Dent Assoc*. 2023;154:826-835.e2. https://doi.org/10.1016/j.adaj.2023.06.015
30. Van Acker JWG, Pauwels NS, Cauwels RGEC, Rajasekharan S. Outcomes of different radioprotective precautions in children undergoing dental radiography: a systematic review. *Eur Arch Paediatr Dent*. 2020;21:463-508. https://doi.org/10.1007/s40368-020-00544-8
31. Pauwels R, Horner K, Vassileva J, Rehani MM. Thyroid shielding in cone beam computed tomography: recommendations towards appropriate use. *Dentomaxillofac Radiol*. 2019;48:20190014. https://doi.org/10.1259/dmfr.20190014
32. Shelley AM, Brunton P, Horner K. Questionnaire surveys of dentists on radiology. *Dentomaxillofac Radiol*. 2012;41:267-275. https://doi.org/10.1259/dmfr/58627082

Downloaded from academic.oup.com/dmfr/advance-article/doi/10.1093/dmfr/twag052/8740992 by Canakkale Onsekiz Mart Universitesi user on 17 August 2026