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KNOWLEDGE, ATTITUDES, AND PRACTICES REGARDING HANDHELD PORTABLE DENTAL X-RAY DEVICES AMONG GENERAL DENTAL PRACTITIONERS: A QUESTIONNAIRE-BASED STUDY

Dr. Sandeep S. Pagare[1], Dr. Mandavi S. Waghmare[2], Dr. Apurva Dhabarde[3], Dr. Chintan Shah[4], Dr Nisha Bharos[5], Dr. Vagisha Choudhary[6]

[1]Professor, Department of Oral Medicine and Radiology, D. Y. Patil University School of Dentistry, Navi Mumbai, Maharashtra, India, Orcid id: 0000000183267576, Email id: professorpagare@gmail.com
[2]Professor and HOD, Department of Oral Medicine and Radiology, D. Y. Patil University School of Dentistry, Navi Mumbai, Maharashtra, India, Orcid id: 0000000189191218, Email id: mandavi.waghmare@dypatil.edu
[3]Postgraduate Student, Department of Oral Medicine and Radiology, D. Y. Patil University School of Dentistry, Navi Mumbai, Maharashtra, India, Orcid id:0009000378913053, Email id: apurvadhabarde24@gmail.com
[4]Lecturer, Department of Oral Medicine and Radiology, D. Y. Patil University School of Dentistry, Navi Mumbai, Maharashtra, India, Orcid id:0009000968419880, Email id: drchintanshah09@gmail.com
[5]Postgraduate Student, Department of Oral Medicine and Radiology, D. Y. Patil University School of Dentistry, Navi Mumbai, Maharashtra, India, Orcid id: 0009000439365637, Email id: nishabharos0805@gmail.com
[6]Postgraduate Student, Department of Oral Medicine and Radiology, D. Y. Patil University School of Dentistry, Navi Mumbai, Maharashtra, India, Orcid id: 0009000959412628, Email id: vagishac14@gmail.com

ABSTRACT

Background: Handheld portable dental X-ray devices provide mobility and may be useful in situations where conventional fixed or semi-mobile radiographic equipment is impractical. However, their use presents specific radiation-protection considerations for operators and patients. Assessing practitioners' knowledge, attitudes, and practices (KAP) is therefore important for promoting safe and appropriate use.

Aim: To assess the knowledge, attitudes, and practices regarding handheld portable dental X-ray devices among general dental practitioners and to determine whether practitioner-related factors are associated with KAP levels.

Materials and Methods: A descriptive analytical cross-sectional questionnaire-based study was conducted among 382 general dental practitioners. A validated online questionnaire comprising 14 knowledge items, 3 attitude items, and practice-related questions was distributed through Google Forms. Data were analyzed using SPSS version 26.0. Descriptive statistics, the Shapiro–Wilk test, and chi-square tests were performed, with the level of statistical significance set at 5%.

Results: The mean knowledge score was 10.43 ± 1.91 out of 14 (74.5%), indicating an overall moderate level of knowledge. Important gaps were observed regarding FDA clearance for routine use (19.9% correct) and PSP sensor compatibility (22.8% correct). The mean attitude score was 2.64 ± 0.68 out of 3, indicating generally favorable attitudes. Protective practices were comparatively less consistent, with 17.5% of respondents reported none of the above listed protective measures. No statistically significant association was observed between years of clinical experience or practice setting and KAP levels ($p>0.05$).

Conclusion: Although general dental practitioners demonstrated moderate knowledge and favorable attitudes toward handheld portable dental X-ray devices, deficiencies were identified in specific areas of knowledge and radiation-protection practices. Targeted education and standardized training may help improve awareness of appropriate indications, regulatory requirements, and radiation-protection measures.

KEYWORDS: Handheld portable X-ray; dental radiography; knowledge; attitudes; practices; radiation protection.

INTRODUCTION

Radiation protection is essential in diagnostic dental imaging. Ionizing radiation should be justified and optimized to obtain the required diagnostic information while minimizing unnecessary exposure. ALARA, ALADA, and ALADAIP provide important frameworks for radiation-risk optimization in dental imaging.[1–3]

Advances in imaging technology have led to portable and handheld dental X-ray devices, which provide an alternative to conventional wall-mounted or semi-mobile units when these are difficult or impractical to use.[4–8] Their portability is particularly beneficial for patients with limited mobility who cannot readily be transferred for radiographic examination.

Handheld portable dental X-ray devices are operated while being held by the user, potentially placing the operator closer to the radiation source than with conventional radiography.[9] Therefore, device design, source-to-skin distance, receptor selection, collimation, backscatter shielding, operator positioning, and exposure parameters should be considered.[9–11]

The clinical use of handheld portable X-ray devices should be carefully justified. The European Academy of Dentomaxillofacial Radiology recommends that they should not routinely replace fixed dental X-ray equipment but may be justified when transferring a patient to fixed or semi-mobile equipment is impractical or impossible.[9] Examples include hospital settings, operation theatres, nursing facilities, and patients with significant mobility limitations.[9,12,13] Although handheld devices offer portability and accessibility, inappropriate positioning, shielding, receptor selection, or repeat exposures may increase radiation exposure.[9,14–18] Protective strategies include appropriate backscatter shielding, recommended operator positioning, suitable collimation and image-receptor holders where compatible, and personal radiation monitoring when indicated.[9,17–19]

The increasing availability of handheld portable X-ray devices highlights the need for practitioners to understand their indications, technical characteristics, radiation risks, and protective measures. Assessing KAP can identify educational needs and areas requiring strengthened radiation-safety training. Therefore, this study assessed KAP regarding handheld portable dental X-ray devices among general dental practitioners and examined associations with years of clinical experience and practice setting.

AIMS AND OBJECTIVES

Aim

- To assess the knowledge, attitudes, and practices (KAP) regarding handheld portable dental X-ray devices among general dental practitioners and to determine factors associated with KAP levels.
- Objectives
- To assess the level of knowledge regarding handheld portable dental X-ray devices, including their technical characteristics and radiation-safety requirements.
- To assess practitioners' attitudes toward the use and safety of handheld portable dental X-ray devices.
- To evaluate current practices and usage patterns related to handheld portable dental X-ray devices.
- To determine the association of years of clinical experience and practice setting with KAP levels.

MATERIALS AND METHODS

Study Design

A descriptive analytical cross-sectional questionnaire-based study was conducted.

Study Duration

The study was conducted over a period of 3 months.

Study Site

The study was conducted in the Department of Oral Medicine and Radiology, D.Y. Patil School of Dentistry, Navi Mumbai, over three months following Institutional Ethics Committee approval (IERB/2026/OMR /15).

Study Population

The study population comprised registered general dental practitioners who had completed formal training in dental radiography.

Sample Size Calculation

The sample size was estimated using SCALEX SP 1.0.01 software based on the prevalence reported in a previous study by Faatihah AU et al.[16]

The sample size was calculated using the following formula:

n=Z2p(1−p)d2n = \frac{Z^2p(1-p)}{d^2}

where:

n = sample size to be determined

Z = statistic corresponding to the 95% confidence level = 1.96

p = expected prevalence of knowledge regarding portable X-ray devices = 43.7%

d = relative precision = 10%

Based on these parameters and the SCALEX SP 1.0.01 calculation, the minimum required sample size was 379 participants. A total of 382 general dental practitioners were included in the study

Inclusion Criteria

1. Practitioners who have completed formal training in dental radiography
2. Registered general dental practitioners
3. Willing to participate in the study

Exclusion Criteria

1. Undergraduates
2. Practitioners who have never used or been trained in dental radiography
3. Practitioners practicing exclusively in non-clinical roles
4. Hygienists
5. Radiology technicians

Data Collection Tool
A validated online questionnaire (Cronbach's α = 0.855; factor loadings >0.361) was distributed via Google Forms. It comprised four sections: demographics; knowledge (14 items); attitude (3 items); and practice (information sources and protective measures). The questionnaire was previously validated by Faatihah et al. (2025).

Statistical Analysis
Data were analysed using SPSS v26.0 software. The level of significance was kept at 5%.
1. Descriptive statistics: Responses were presented using frequency and percentage.
2. Normality assessment: Data were subjected to normality assessment using the Shapiro-Wilk test.
3. Scoring:
- **Knowledge score:** 1 point for each correct answer (maximum 14)
- **Attitude score:** 1 point for favourable response (maximum 3)
- **Practice score:** Practice was assessed using six radiation-protection measures listed in Q22: lead apron, personal dosimeter, thyroid collar, backscatter shield, fully extended arms, and rectangular collimation. Each selected protective measure was assigned 1 point and each unselected measure was assigned 0 points, resulting in a maximum possible practice score of 6. The responses "None of the above" and "Not applicable" were not assigned points. Q21, which assessed sources of information regarding handheld portable X-ray devices, was analysed separately using descriptive statistics and was not included in the practice score.

4. Categorization: Since the practice scores were not normally distributed (Shapiro–Wilk W = 0.892, $p < 0.001$), the median practice score of 1 was used as the cut-off for categorical analysis. Participants with practice scores ≥1 were categorized as having a higher practice score, whereas those with scores <1 were categorized as having a lower practice score.
5. Association analysis: Categorical responses were compared using the chi-square test.

RESULTS
A total of 382 responses were included in the final analysis (n = 382), exceeding the minimum calculated sample size of 379.
Demographic Characteristics of Study Participants

Table 1: Demographic Characteristics of Study Participants

Variable	Category	Frequency (n)	Percent (%)
Years of clinical experience	Less than 1 year	62	16.2
	1–5 years	192	50.3
	6–10 years	29	7.6
	More than 10 years	99	25.9
Type of practice setting	Private practice	181	47.4
	Academic / Teaching institution	138	36.1
	Government / Public health clinic	38	9.9
	Community outreach / Mobile dentistry	3	0.8
	Other	22	5.8
Access to handheld device	Yes, currently use one	175	45.8
	No, but used previously	97	25.4
	No, never used one	100	26.2
	Planning to buy one	10	2.6

Most respondents had 1–5 years of clinical experience (50.3%), followed by >10 years (25.9%), <1 year (16.2%), and 6–10 years (7.6%). Nearly half worked in private practice (47.4%), followed by academic/teaching institutions (36.1%). Regarding handheld-device access, 45.8% currently used one, 25.4% had used one previously, 26.2% had never used one, and 2.6% planned to purchase one.

2. Knowledge of Radiation Safety and Device Specifications

Table 2: Responses to Knowledge Questions on Handheld Portable X-ray Devices

Item	Statement	Correct Answer	n Correct	% Correct
Q4	Lower mA & longer exposure time vs wall-mounted units	Yes	230	60.2
Q5	Advantage: eliminates need for multiple fixed units	Yes	348	91.1
Q6	Typically operate at fixed tube voltage of 60 kV	Yes	280	73.3

Q7	Typical source-to-skin distance (SSD) ~20 cm	Yes	294	77.0
Q8	Digital sensors/F-speed film recommended to minimize dose	Yes	337	88.2
Q9	PSP sensors show best compatibility for image quality	No	87	22.8
Q10	Primary concern: operator scatter radiation from proximity	Yes	328	85.9
Q11	Backscatter shield reduces operator exposure	Yes	339	88.7
Q12	Paediatric/pregnant patients need special consideration	Yes	326	85.3
Q13	Most appropriate for immobile/domiciliary patients	Yes	344	90.1
Q14	Operator position 90°–135° behind backscatter shield	Yes	327	85.6
Q15	Image quality equivalent to conventional wall-mounted	Yes	324	84.8
Q16	FDA-cleared for routine use without any restrictions	No	76	19.9
Q17	Dosimetry should include whole-body + extremity	Yes	343	89.8

Overall knowledge score was 10.43 ± 1.91 out of 14, with a median of 11.0 (IQR: 9.0–12.0). The highest correct responses concerned the elimination of multiple fixed units as an advantage (91.1%), use for immobile/domiciliary patients (90.1%), and backscatter shielding (88.7%). The lowest were observed for FDA clearance and unrestricted routine use (19.9%) and PSP sensor compatibility (22.8%).

3. Attitude Toward Handheld Portable X-ray Devices

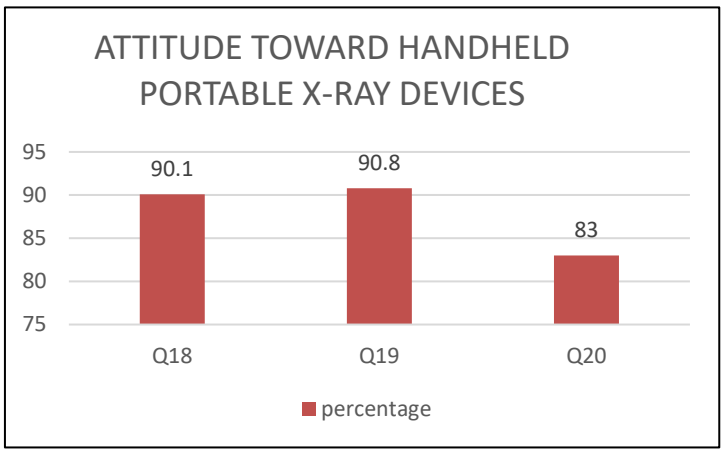

Figure 1: Attitudes toward handheld portable dental X-ray devices

Overall attitude score: The mean ± SD score was 2.64 ± 0.68 out of 3, with a median (IQR) of 3.0 (2.0–3.0).
Most respondents considered handheld devices safe when appropriate protective measures were used (90.1%) and supported their use for specific clinical indications (90.8%). Additionally, 83.0% expressed interest in participating in training programs or workshops regarding their safe use.

4. Current Practices and Usage Patterns
Q21 and Q22 permitted multiple responses per participant; percentage therefore do not sum to 100%.

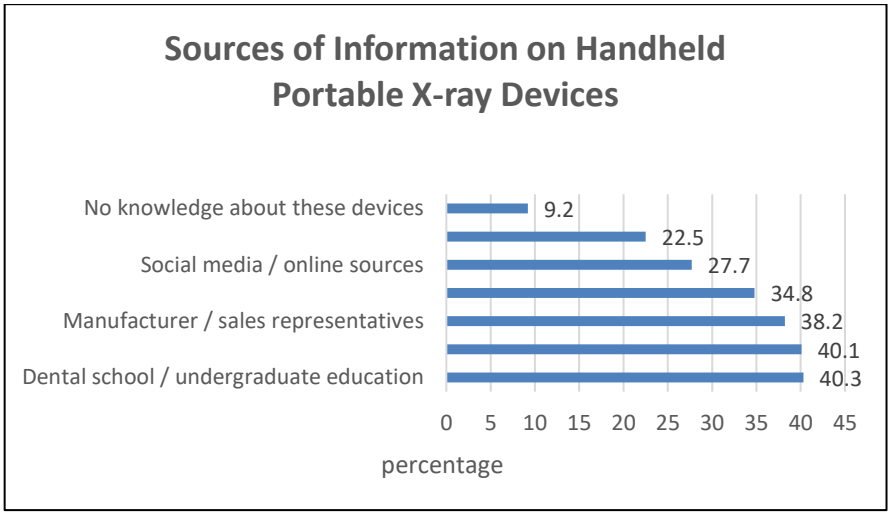

Figure 2: Sources of Information on Handheld Portable X-ray Devices

Table 3: Protective Measures Used When Operating the Device

Protective Measure	Percentage
Lead apron (0.5 mm Pb equivalent)	51.8
Personal dosimeter (TLD/OSL badge)	27.7
Thyroid collar	26.7
Not applicable — do not use handheld devices	23.0
Backscatter shield (acrylic/lead composite)	22.8
Arms fully extended away from beam	20.9
None of the above	17.5
Rectangular collimator	12.0

Practice Patterns

The mean practice score was 1.62 ± 1.68 out of 6, with a median of 1.0 (IQR: 0.0–3.0). Lead aprons were the most frequently reported protective measure (51.8%), followed by personal dosimeters (27.7%) and thyroid collars (26.7%), whereas rectangular collimation was least reported (12.0%). Overall, 17.5% selected "None of the above." Dental school education and peer discussion were the most frequently reported information sources.

5. Normality Assessment

Table 4: Shapiro-Wilk Test of Normality for KAP Scores

Score	W Statistic	p-value	Distribution
Knowledge score (max 14)	0.903	<0.001	Not normal
Attitude score (max 3)	0.581	<0.001	Not normal
Practice score (max 6)	0.844	<0.001	Not normal

All three KAP scores significantly deviated from a normal distribution (Shapiro–Wilk $p < 0.001$). Therefore, scores were dichotomized using the respective median values as cut-offs for categorical association analysis.

Table 5: Median-Split Cut-offs and KAP Level Distribution

Domain	Median Cut-off	Higher, n (%)	Lower, n (%)
Knowledge (max 14)	11	217 (56.8%)	165 (43.2%)
Attitude (max 3)	3	281 (73.6%)	101 (26.4%)
Practice (max 6)	1	260 (68.1%)	122 (31.9%)

6. Association Between Practitioner Factors and KAP Levels

Chi-square tests of association were performed between practitioner-related factors (years of clinical experience, type of practice setting) and Knowledge, Attitude, and Practice levels (higher/lower, median-split). For practice setting, the 'Community outreach/Mobile dentistry' category (n=3) was merged with 'Other' to satisfy the chi-square assumption of expected cell counts ≥5.

Table 6: Association Between Years of Clinical Experience and KAP Levels

KAP Domain	χ^2	df	p-value	Significance
Knowledge level	0.455	3	0.929	Not significant
Attitude level	0.758	3	0.859	Not significant

Practice level	1.120	3	0.772	Not significant

Table 7: Association Between Type of Practice Setting and KAP Levels

KAP Domain	χ^2	df	p-value	Significance
Knowledge level	3.818	3	0.282	Not significant
Attitude level	5.457	3	0.141	Not significant
Practice level	0.666	3	0.881	Not significant

No statistically significant association was found between years of clinical experience or type of practice setting and Knowledge, Attitude, or Practice levels ($p>0.05$ for all comparisons). This suggests that KAP regarding handheld portable X-ray devices was relatively uniform across practitioners irrespective of their years of clinical experience or the type of practice setting in which they work.

DISCUSSION

This study assessed KAP regarding handheld portable dental X-ray devices among 382 general dental practitioners. Overall, respondents demonstrated moderate knowledge, favourable attitudes, and comparatively inconsistent radiation-protection practices, with gaps in regulatory awareness and device–receptor compatibility.

Knowledge Regarding Handheld Portable Dental X-ray Devices

The mean knowledge score in the present study was 10.43 ± 1.91 out of 14 (74.5%), indicating a moderate overall level of knowledge. Respondents demonstrated good understanding of several important aspects of handheld portable X-ray devices. The highest proportion of correct responses was observed for the perceived advantage of reducing the need for multiple fixed X-ray units (91.1%), followed by the appropriate use of handheld devices for immobile or domiciliary patients (90.1%). These findings suggest that most practitioners were aware of the potential clinical utility and portability advantages of these systems.

Knowledge of radiation protection was relatively strong, with 88.7% recognizing the role of backscatter shielding, 85.3% the need for special consideration in paediatric and pregnant patients, 85.6% appropriate operator positioning, and 89.8% whole-body and extremity dosimetry. These findings indicate reasonable awareness of fundamental radiation-protection principles.[5,9,15,17–19]

Only 19.9% correctly answered the questionnaire item concerning FDA clearance and unrestricted routine use, suggesting limited regulatory awareness. However, this finding should be interpreted in the context of the questionnaire wording and should not imply that handheld dental X-ray devices lack regulatory clearance. Regulatory status, indications, labelling, and conditions of use vary by device and applicable regulations. The EADMFR recommends justified use and advises against routinely replacing fixed or semi-mobile equipment when patient transfer is feasible.[9]

Only 22.8% correctly answered the PSP sensor compatibility item, suggesting uncertainty regarding image-receptor selection. However, compatibility and image quality depend on the specific device, receptor characteristics, and exposure parameters; therefore, this finding should not be interpreted as evidence that PSP receptors are universally unsuitable.

Overall, practitioners appeared familiar with the clinical utility and broad radiation-safety principles of handheld devices but less confident regarding technical and regulatory details. Continuing dental education should therefore emphasize device specifications, regulatory requirements, receptor compatibility, exposure parameters, and appropriate indications..

Attitudes Toward Handheld Portable Dental X-ray Devices

Attitudes toward handheld portable dental X-ray devices were predominantly favourable. Most respondents considered them safe when appropriate protective measures were used (90.1%) and supported their use for specific clinical indications (90.8%); 83.0% expressed interest in further training. This favourable attitude may reflect recognition of their usefulness in selected situations where conventional radiography is difficult to access, while the interest in training suggests a need for additional guidance on safe use.

Practice Patterns and Radiation-Protection Measures

Practice showed greater variability than knowledge and attitude scores. The mean practice score was 1.62 ± 1.68 out of 6, with a median of 1.0 (IQR: 0.0–3.0). Lead aprons were the most frequently reported protective measure (51.8%), followed by personal dosimeters (27.7%) and thyroid collars (26.7%), while backscatter shields (22.8%), fully extended arms (20.9%), and rectangular collimation (12.0%) were less frequently reported.

Low reporting of backscatter shielding and appropriate operator positioning is noteworthy because handheld devices are operated close to the radiation source. Previous studies and the EADMFR position paper emphasize the importance of operator positioning and appropriate shielding.[5,9,15,18]

Personal dosimeter use was relatively low and should be interpreted cautiously, as monitoring requirements vary according to national regulations, institutional policies, and radiation-risk assessments.[9,19] Thus, the finding indicates a need for clearer guidance regarding when personal monitoring is recommended or required rather than necessarily indicating non-compliance.

Rectangular collimation was the least frequently reported protective measure (12.0%). Previous research has shown that it can reduce operator exposure during portable intraoral radiography.[15] Device-specific training may therefore improve awareness of appropriate collimation.

An important finding was the discrepancy between favourable attitudes and the relatively limited reporting of several protective practices. This suggests that awareness of radiation safety does not necessarily translate into consistent

implementation of recommended protective measures. Because the present study relied on self-reported practices, this finding should be interpreted as an indication of reported behaviour rather than directly observed clinical practice.

Sources of Information

Dental school/undergraduate education (40.3%) and peer discussion (40.1%) were the most frequently reported information sources, followed by manufacturer/sales representatives (38.2%) and continuing dental education (34.8%). Scientific journals were reported by only 22.5% of participants.

The 9.2% reporting no knowledge indicates variable access to information about this specialized technology. Practitioners should therefore be encouraged to consult evidence-based guidelines, regulatory documents, and peer-reviewed literature, as information from manufacturers, social media, or informal peer discussion may vary in accuracy and completeness.

Association Between Practitioner Factors and KAP Levels

No statistically significant association was identified between years of clinical experience and knowledge, attitude, or practice levels. Similarly, no statistically significant association was observed between type of practice setting and any of the three KAP domains ($p > 0.05$).

The absence of significant associations with clinical experience suggests that greater experience alone may not translate into greater familiarity with handheld X-ray technology, possibly because these systems are relatively specialized and evolving. Similarly, the lack of differences across practice settings suggests that the identified gaps were not restricted to a particular professional environment.

These findings should not be interpreted as evidence that groups are identical, as smaller subgroup differences may have gone undetected and median-based categorization may have reduced sensitivity. Standardized radiation-safety education should therefore address both theoretical and practical aspects, including indications, device-specific requirements, positioning, shielding, collimation, receptor selection, and regulatory requirements.

Clinical Implications

The findings support targeted education on regulatory requirements, device–receptor compatibility, and practical radiation-protection measures, particularly backscatter shielding, operator positioning, and appropriate collimation. Practitioners should also receive clear guidance on device-specific instructions, approved indications, and applicable radiation-safety regulations.

Continuing dental education programs could incorporate practical demonstrations and competency-based training to bridge the gap between favorable radiation-safety attitudes and reported protective practices.

LIMITATIONS

This study has several limitations. First, the cross-sectional design limits causal inference. Second, self-reported responses may have introduced reporting and social-desirability bias, particularly regarding radiation-protection practices. Third, recruitment from a limited geographical setting may restrict generalizability. Fourth, the online format may have introduced selection bias. Finally, reported practices were not directly observed and may therefore differ from actual clinical behaviour.

CONCLUSION

The present study demonstrated moderate knowledge and generally favourable attitudes toward handheld portable dental X-ray devices among general dental practitioners, but identified gaps in regulatory awareness, receptor compatibility, and radiation-protection practices. No significant associations were observed between KAP levels and years of clinical experience or practice setting. These findings support structured, evidence-based education focusing on appropriate indications, regulatory requirements, device-specific considerations, and practical radiation-protection measures.

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