ORIGINAL ARTICLE

Knowledge, Awareness, Attitude, and Practices on Radiation Protection and Radiation Safety Among Dental Surgeons in Melaka, Malaysia

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ABSTRACT

Introduction: Radiation protection during diagnostic imaging is essential in dental practice. Although associated risks are low, adherence to safety guidelines is vital to minimize unnecessary exposure for patients and practitioners. The National Council on Radiation Protection (NCRP) and International Commission on Radiological Protection (ICRP) recommend evidence-based protocols, including the ALARA (As Low As Reasonably Achievable) principle. This study assessed knowledge, awareness, attitudes, and practices regarding radiation protection among dentists and dental specialists in Melaka, Malaysia. **Methods:** A cross-sectional survey was conducted among Malaysian dentists and dental specialists in private clinics in Melaka. A self-administered multiple-choice questionnaire gathered sociodemographic data, knowledge of radiation safety measures, and practices during dental radiographic procedures. Data were analysed by clinical experience level. **Results:** Of 117 participants, 71.8% were familiar with the ALARA principle, but only 36.8% knew specific NCRP and ICRP recommendations. Use of lead aprons and thyroid collars was more common among dentists with over 15 years' experience and those with 1–5 years' experience. Practitioners with 1–5 years' experience demonstrated the highest awareness of dose reduction strategies.
Conclusion: While ALARA awareness is high, knowledge of international recommendations is limited. Lead apron and thyroid collar use persists despite current American Dental Association guidance to discontinue their routine use due to negligible dose reduction and possible workflow hindrance. Targeted continuing education, particularly for practitioners with more than five years' experience, is needed to align clinical practice with evidence-based guidelines and enhance patient safety.
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INTRODUCTION

Dental radiographs are indispensable in the diagnosis and management of diseases affecting the teeth and maxillofacial region. Their applications range from the detection of dental caries to the evaluation of complex conditions such as maxillofacial trauma, assessment of malocclusions, planning for dental implants, and monitoring prognosis. While these imaging techniques are invaluable, the ionizing radiation used to produce them carries potential risks to biological tissues.

Radiation-induced harm is broadly classified into deterministic effects, where severity increases with dose, and stochastic effects, where the probability of occurrence rises proportionally with dose. According to Linear No-Threshold (LNT) model, any exposure to ionizing radiation-no matter how minimal-carries some risk which increases linearly with dose (1). In practical terms, doubling the dose proportionally doubles the likelihood of an adverse effect. Ionizing radiation exposure is also associated with an increased risk of malignancies (2). Hence, the justification for obtaining any radiographic image must clearly outweigh the potential risks associated with radiation exposure.

Dental imaging procedures can result in patient exposures ranging from approximately 1.5 μSv for intraoral radiographs to 1,200 μSv for cone-beam computed tomography (CBCT) (3,4). In recent years, the increased and sometimes indiscriminate use of CBCT for diagnosis and treatment planning has raised concerns, particularly due to the cumulative nature of radiation exposure over a lifetime. Even though the radiation dose from individual dental imaging procedures is relatively low, repeated exposures may contribute to long-term stochastic risks for both patients and dental professionals. Therefore, the guiding principle for clinicians remains primum non nocere-a maxim attributed to Hippocrates, meaning "first, do no harm"(5).

To safeguard against these risks, the International Commission on Radiological Protection (ICRP) (6) has outlined three fundamental principles of radiation protection: Justification (only performing radiographs when benefits exceed associated risks), Optimisation (keeping doses As Low As Reasonably Achievable (ALARA) and Dose limitation (adhering to legal exposure limits for occupational and public safety). These principles are increasingly important given the rise in CBCT usage, especially in paediatric dentistry, where personalized dose optimization-referred to as ALADAIP (As Low As Diagnostically Acceptable, being Indication-oriented and Patient-specific) is gaining traction (7). Practical measures to achieve these principles include the use of digital radiography, tailoring imaging parameters by patient demographics, maintaining equipment rigorously, and regular checks for inadvertent radiation leakage.

In Malaysia, the Atomic Energy Licensing Board (AELB) enforces radiation safety under the Atomic Energy Licensing Act 304 (1984) (8). The Quality Assurance Program (QAP) initiated by the Ministry of Health in 1985, aims to ensure effective use of resources and improve the quality and safety of radiological services. AELB requires that all radiation workers undergo initial training and periodic refresher courses in radiation safety, with programs offered by institutions such as Universiti Teknologi Malaysia (9).

Several studies have evaluated knowledge, awareness, attitudes, and practices (KAAP) in radiation protection with varying results (10–12). For instance, A 2024 study at Jazan univeristy, Saudi Arabia, reported that 91% of undergraduate students of various academic year recognised dental X-rays as hazardous to health, among whom 79% used lead aprons and 85% of them stood behind the lead barrier during exposure (13). A 2018 study in Negeri Sembilan, Malaysia found that 52.3% of healthcare workers had high knowledge, 80.8% had positive attitudes, and 56.3% demonstrated good practices in radiation protection (14). However, literature specifically targeting dental practitioners of Melaka state that borders Sembilan is lacking. Since licensed dental practitioners play a critical role in safeguarding patients and operators from ionizing radiation, evaluating their knowledge, awareness, attitudes, and practices (KAAP) is essential to ensure adherence to established guidelines and the principles of justification, optimization, and dose limitation. This study assesses the KAAP of dental practitioners in Melaka's three districts—Jasin, Melaka Tengah, and Alor Gajah—focusing on compliance with evidence-based radiation protection and safety standards.

MATERIALS AND METHODS

This cross-sectional study was designed to evaluate KAAP regarding radiation protection and safety during dental imaging procedures among dental practitioners in Melaka, Malaysia. A purposive sampling strategy was employed to recruit general dentists and dental specialists working in private dental clinics within Melaka state who were registered with the Malaysian Dental Council. Government-employed dental surgeons in clinics or hospitals, dental practitioners not currently practicing in Melaka, and those who could not be contacted were excluded from the study. A total sample size of 117 was determined using Cochran's formula at a 95% confidence level ($p < 0.05$), based on study estimate of 85.6%,15 with an additional 20% added to account for potential non-response rate.

This study was approved by Research Ethics Committee, Manipal University College Malaysia No.014/2023. A self-administered questionnaire was adapted from a previously validated instrument15 and further refined for this study. To enhance validity, the questionnaire underwent a rigorous two-step validation process involving both face and content validation. Ten subject-matter experts specialised in dental radiology, public health, and research methodology reviewed the tool for clarity, relevance, and comprehensiveness. Based on their feedback, revisions were made to improve the precision and appropriateness of the items. The final questionnaire consisted of three sections: A) Sociodemographic data (gender, age, nationality, educational qualifications and years of clinical experience) B) Knowledge and Awareness (seven items assessing understanding of radiation protection principles, safety measures, and awareness of associated risks during dental imaging) and C) Attitudes and Practices (nine items evaluating respondents' outlook toward radiation safety protocols and their implementation in routine clinical practice).

The questionnaire was administered electronically to 117 general dentists and dental specialists with varied professional qualifications and years of experience (to ensure diversity and representativeness) via google forms, with the survey link disseminated through email to facilitate accessibility and participation.

Data were compiled and coded using Microsoft

Excel 2016, with subsequent statistical analysis to assess patterns and correlations in KAAP levels across different demographic and professional subgroups. Data analysis was done using SPSS 23.0 version software and Microsoft Excel Sample Calculator. Descriptive statistics such as frequency and percentage was used to measure the sociodemographic profile of study sample. Chi square test (Fischer Exact test for sample <30) was used to determine the knowledge, awareness, attitude and practice against various years of clinical experience on radiation protection and radiation safety during dental imaging procedures. 95% confidence level was calculated. pvalue less than 0.05 ($p < 0.05$) was considered statistically significant. Cut off point was set at 50% (Good > 50%; Poor <50%).

RESULTS

The sociodemographic characteristics of the study participants are presented in (Table I). A total of 117 general dentists and dental specialists completed the questionnaire, of whom 63.2% were female and 36.8% male. The largest proportion of respondents (44.4%) were aged between 31–40 years, with no participants in the 61-70year age group. The majority (98.3%) were Malaysian nationals. Most participants were general dentists (94.0%), while 6.0% were dental specialists. In terms of clinical experience, 35.9% had been practicing for 6-10 years, followed by >15 years (26.5%), 1-5 years (21.4%), and 11-15 years (16.2%). This distribution provided a diverse range of professional backgrounds for analysis.

Responses to knowledge and awareness questions on radiation protection are summarized (Table II and Table III). While overall knowledge levels were similar across different clinical experience groups, notable gaps emerged in specific areas. Most participants (71.8%) reported familiarity with the ALARA principle but only 36.8% of participants were familiar with the recommendations of the National Council on Radiation Protection and Measurements (NCRP) and the International Commission on Radiological Protection (ICRP), and just 41.0% were aware of the 6-foot minimum distance recommended by the Position–Distance Rule. Practitioners with 11-15 years of experience (63.2%) showed comparatively higher awareness of the Position-Distance Rule.

Table 1: Sociodemographic profile of study participants (N = 117)

Variable	Category	n	%
Gender	Male	43	36.8
	Female	74	63.2
Age	21–30	27	23.0
	31–40	52	44.4
	41–50	28	23.9
	51–60	9	7.7
	61–70	0	0.0
	71–80	1	0.85
Nationality	Malaysian	115	98.3
	NonMalaysian	2	1.7
Qualification	General dentist	110	94.0
	Dental specialist	7	6.0
Years of clinical experience	1–5 years	25	21.4
	6–10 years	42	35.9
	11–15 years	19	16.2
	>15 years	31	26.5

Table II: Dental surgeons' knowledge and awareness towards radiation protection and safety (N = 117)

Question	Response	n	%
Are you familiar with ALARA principle?	Yes	84	71.8
	No	33	28.2
Are you familiar with the recommendations of the NCRP and ICRP?	Yes	43	36.8
	No	74	63.2
Are you aware of the radiation hazard symbol?	Yes	117	100.0
	No	0	0.0
Does digital radiography require less exposure than conventional?	Yes	71	60.7
	No	14	12.0
	I do not know	32	27.4
Do highspeed films reduce exposure?	Yes	63	53.8
	No	10	8.5
	I do not know	44	37.6
Specify the importance of the use of collimators and filters in dental radiography.	Very important	71	60.7
	Important	39	33.3
	Moderately important	7	6.0
	Of little importance	0	0.0
	Unimportant	0	0.0
What is the ideal distance of operator "Position Distance Rule" when exposed to dental radiography?	6 feet	48	41.03
	2 metres	20	17.09
	5 metres	10	8.55
	Others	39	33.33

Universal awareness (100%) of the radiation hazard symbol was observed. More than half (60.7%) identified digital radiography as reducing exposure, and 53.8% recognised that high-speed films also reduce exposure. Regarding equipment, 60.7% rated collimators and filters as "very important." However, this knowledge showed no statistically significant differences by years of clinical experience ($P > 0.05$). Overall, 88.9% (n = 104) demonstrated good knowledge, with 11.1% (n = 13) scoring in the poor category. These findings indicate that while fundamental knowledge and awareness exists, specific technical recommendations are less widely understood, suggesting the need for targeted educational interventions.

Attitudes and practices toward radiation protection, stratified by clinical experience, are shown in (Tables IV and V). Lead apron use during exposure was "very

Table III: Dental surgeons' knowledge and awareness towards radiation protection and radiation safety according to their clinical experience.

Questions	Responses	Clinical experience (years) n(%)				Chi- square test	p- value
		1-5	6-10	11-15	>15		
Are you familiar with ALARA principle?	Yes	18 (72%)	31(73.8%)	12(63.2%)	23(74.2%)	0.873[a]	0.842
	No	7 (28%)	11(26.2%)	7(36.8%)	8(25.8%)		
Are you familiar with the recommendations of the NCRP and ICRP?	Yes	8 (32%)	19(45.2%)	3(15.8%)	13(41.9%)	5.494[a]	0.138
	No	17 (68%)	23(54.8%)	16(84.2%)	18(58.1%)		
Are you aware of the radiation hazard symbol?	Yes	25 (100%)	42(100%)	19(100%)	31(100%)	-	0.999
	No	0 (0%)	0(0%)	0(0%)	0(0%)		
Does digital radiography require less exposure than conventional?	Yes	18 (72%)	21(50%)	11(57.9%)	21(67.8%)	4.060[a]	0.256
	No	2 (8%)	8(19%)	3(15.8)	1(3.2%)		
	I do not know	5 (20%)	13(31%)	5(26.3%)	9(29%)		
Do high-speed films reduce exposure?	Yes	17 (68%)	21(50%)	8(42.1%)	17 (54.8%)	3.331[a]	0.348
	No	1(4%)	5 (11.9%)	1(5.3%)	3 (9.7%)		
	I do not know	7(28%)	16(38.1)	10 (52.7%)	11 (35.5%)		
Specify the importance of the use of collimators and filters in dental radiography.	Very	19(76%)	25(59.5%)	11 (57.9%)	16 (51.6%)	5.945[b]	0.408
	Important + important	5 (20%)	16(38.1%)	6 (31.6%)	12 (38.7%)		
	Moderately important	1 (4%)	1 (2.4%)	2 (10.5%)	3 (9.7%)		
	of little	0 (0%)	0 (0%)	0 (0%)	0 (0%)		
	Important + unimportant	0 (0%)	0 (0%)	0 (0%)	0 (0%)		
What is the ideal distance of operator ' Position Distance Rule' when exposed to dental radiography?	6 feet	9 (36%)	19(45.2%)	12 (63.2%)	11 (35.5%)	3.539[a]	0.318
	2 metres	9 (36%)	4 (9.5%)	2 (10.5%)	5 (16.1%)		

	Clinical experiences (years) n (%)				Chi square test	p - value
	6-10	11-15	>15	Total		
	24 (96%)	38(90.5%)	16 (84.2%)	26 (83.9%)	104 (88.9%)	2.660	0.452
	1 (4%)	4 (9.5%)	3 (15.8%)	5 (16.1%)	13 (11.1%)		

[a] Chi-Square Test
[b] Fisher's Exact Test (expected frequency <5 in > 20% of the cells)

frequent" among 85.5% (n = 100) of participants, although the use of thyroid collars was less consistent (49.6%). Use of lead aprons was directly proportional to the years of experience with all (100%) the dental practitioners having 6-15 years' experience using them. However, no statistically significant differences were observed in these practices based on years of clinical experience (P > 0.05). 44.4% (n = 52) of the participants occasionally allowed patients to hold films, 33.3% (n = 39) rarely or never (11.1%) did so while only the rest 11.1% admitted to asking patients to hold the film during exposure frequently. Regarding operational safety, standing behind a lead barrier during exposure was "very frequent" in 61.5% (n = 72), and maintaining a 6-foot distance was "very frequent" in 45.3% (n = 53). Practices related to remaining within the same clinic during X-ray exposure varied, with 36.8% (n = 43) indicating they very frequently did so, yet over half (52.2%) rarely or never used lead aprons in this context. Again, no significant association was found between these practices and years of clinical experience (P > 0.05). A high proportion of participants (69.2%) reported displaying caution or warning signs during radiographic procedures. However, dental surgeons with 1–5 years of experience were less consistent, with 48% rarely or never displaying such warnings. All participants met the scoring criteria for good attitude/practice. As shown in Table 5, no significant associations were found between clinical experience and most knowledge items (p > 0.05). The only significant difference in practice was

Table IV: Dental surgeons' attitude and practice towards radiation protection and safety (N = 117)

Question	Response	n	%
Do you use lead apron for patients during exposure?	Very frequently	100	85.5
	Frequently	15	12.8
	Occasionally	2	1.7
	Rarely	0	0.0
	Never	0	0.0
Do you use thyroid collar for patients during exposure?	Very frequently	58	49.6
	Frequently	15	12.8
	Occasionally	17	14.5
	Rarely	26	22.2
	Never	1	0.9
Do you ask patients to hold the film?	Very frequently	6	5.1
	Frequently	7	6.0
	Occasionally	52	44.4
	Rarely	39	33.3
	Never	13	11.1
Do you stand behind a lead barrier during exposure?	Very frequently	72	61.5
	Frequently	25	21.4
	Occasionally	11	9.4
	Rarely	7	6.0
	Never	2	1.7
If within the same area, do you stand 6 feet away from primary Xray beam during exposure?	Very frequently	53	45.3
	Frequently	31	26.5
	Occasionally	17	14.5
	Rarely	13	11.1
	Never	3	2.6
Do you hold the film in the patient's mouth during exposure?	Very frequently	4	3.4
	Frequently	4	3.4
	Occasionally	43	36.8
	Rarely	46	39.3
	Never	20	17.1
Do you stay within the same room during Xray exposure?	Very frequently	43	36.8
	Frequently	20	17.1
	Occasionally	23	19.7
	Rarely	20	17.1
	Never	11	9.4
If you decided to stay within the same room during exposure, do you use a lead apron on a regular basis?	Very frequently	21	17.9
	Frequently	17	14.5
	Occasionally	18	15.4
	Rarely	47	40.2
	Never	14	12.0
Do you display caution or hold a warning sign while exposed to Xray?	Very frequently	81	69.2
	Frequently	21	17.9
	Occasionally	7	6.0
	Rarely	8	6.8
	Never	0	0.0

apron use when remaining in the same room during exposure (p = 0.042), which was most frequent (45.2%) among practitioners with >15 years' experience. Overall, these results indicate good compliance with core safety measures but highlight variability in specific protective practices. The absence of consistent patterns by clinical experience suggests that factors other than years in practice may influence adherence to optimal radiation safety behaviours.

DISCUSSION

The present study provides valuable insights into the knowledge, awareness, attitudes, and practices (KAAP) regarding radiation protection and safety among dentists and dental specialists in Melaka, Malaysia. Overall, 88.9% of participants demonstrated good knowledge and awareness, indicating a generally strong comprehension of radiation hazards and safety protocols. This level of understanding is encouraging and suggests that dentists in Melaka apply safe imaging practices that minimize radiation risks for both patients and operators. Comparable research in other regions has reported lower awareness levels (15,16). For instance, a study among dental practitioners in Saudi Arabia found that awareness of radiation hazards was suboptimal (60.79%) (13). The higher awareness observed in the current study may be attributed to differences in professional training, local regulations, and the accessibility of continuing education opportunities in Malaysia.

The present study also revealed that knowledge and awareness of fundamental radiation safety concept such as the ALARA principle, the radiation hazard symbol, and the position distance rule were consistently understood by dental and dental specialists across all levels of clinical experience. The results are in accordance with the results of the study by Ageeli et al.(13) Interestingly, practitioners with fewer years of practice, often recent graduates, demonstrated greater familiarity with newer technological advances such as digital radiography and high-speed films, both of which contribute to reduced radiation exposure for patients. This trend mirrors previous research showing that postgraduate students and undergraduate students of higher academic year possess a higher level of knowledge regarding digital radiography compared to undergraduate students (13,16). Similarly, a study from the Netherlands found that high-technology adopters were generally younger dentists,17reinforcing our observation that younger practitioners are more engaged with advanced imaging modalities. In addition, younger dentists in our study scored higher on knowledge related to the use of collimators and filters in dental radiography, which was consistent with findings from Saudi Arabia, where dental students displayed the highest knowledge

Table V: Dental surgeons' attitude and practice towards radiation protection and radiation safety according to their clinical experience.

Questions	Responses	Clinical experiences (years) n (%)				Chi square test	p-value
		1-5	6-10	11-15	>15		
Do you use lead apron for patients during exposure?	Frequently	24 (96%)	42(100%)	19 (100%)	30 (96.8%)		
	Occasionally	1 (4%)	0 (0%)	0 (0%)	1 (3.2%)	2.453[a]	0.527
	Rarely + Never	0 (0%)	0 (0%)	0 (0%)	0 (0%)		
Do you use thyroid collar for patients during exposure?	Frequently	18(72%)	21 (50%)	13 (68.4%)	21 (67.8%)		
	Occasionally	3(12%)	9 (21.4%)	0 (0%)	5(16.1%)	9.298[a]	0.146
	Rarely + Never	4 (16%)	12 (28.6%)	6 (31.6%)	5(16.1%)		
Do you ask patients to hold the film?	Frequently	4 (16%)	6(14.3%)	1 (5.3%)	2(6.5%)		
	Occasionally	12 (48%)	17 (40.5%)	9(47.4%)	14(45.1%)		
	Rarely + Never	9 (36%)	19(45.2%)	9 (47.3%)	15(48.4%)	5.530[a]	0.477
Do you stand behind a lead barrier during exposure?	Frequently	24 (96%)	32(76.2%)	15 (79%)	26(83.9%)		
	Occasionally	0 (0%)	7 (16.7%)	2(10.5%)	2(6.5%)	5.649[a]	0.447
	Rarely + Never	1 (4%)	3 (7.1%)	2(10.5%)	3(9.6%)		
If within the same area, do you stand 6 feet away from primary x- ray beam during exposure?	Frequently	19(76%)	28(66.7%)	15(79%)	22(71%)		
	Occasionally	3(12%)	8(19%)	2(10.5%)	4(12.9%)	2.532[a]	0.886
	Rarely + Never	3(12%)	6(14.3%)	2(10.5%)	5(16.1%)		
Do you hold the film in the patients' mouth during exposure?	Frequently	1(4%)	6(14.3%)	0(0%)	1(3.2%)		
	Occasionally	13 (52%)	11 (26.2%)	8 (42.1%)	11(35.5%)	5.077[a]	0.531
	Rarely + Never	11(44%)	25 (59.5%)	11(57.9%)	19(61.3%)		
Do you stay within the same room during X- ray exposure?	Frequently	16(64%)	21(50%)	12(63.2%)	14 (45.1%)		
	Occasionally	5 (20%)	9 (21.4%)	3 (15.8%)	6 (19.4%)	4.486[a]	0.620
	Rarely + Never	4 (16%)	12 (28.6%)	4 (21%)	11(35.5%)		
If you decided to stay within the same room during X- ray exposure, do you use lead apron on a regular basis?	Frequently	6(24%)	14(33.33%)	4 (21.05%)	14(45.16%)		
	Occasionally	4 (16%)	6 (14.29%)	4 (21.05%)	4 (12.9%)	12.675[a]	0.042[c]
	Rarely + Never	15 (60%)	22(52.38%)	11(57.89%)	13(41.94%)		
Do you display caution or hold a warning sign while exposed to X-ray?	Frequently	13 (52%)	37 (88.1%)	19(100%)	27(87.1%)	3.451[a]	0.788

levels on this topic, followed by dentists and dental staff (18). These results may be attributed to the integration of structured radiology courses and updated training modules in dental curricula, as well as exposure to technology-focused conferences. Younger dentists also gain hands-on experience with digital techniques during their formal education, which shapes their subsequent clinical practice.

However, 63.2% of our respondents were unaware of the NCRP and ICRP guidelines that governs permissible radiation doses for occupationally exposed individuals and the public. This is in concurrence with findings from other studies where respondents were unfamiliar with these recommendations (18,19). Reinforcing these guidelines through targeted continuing education and policy reinforcement remains an urgent priority since these international standards are designed for radiation safety and protection of patients and personnel.

Results of the inferential analysis infer that all dentists in this study demonstrated commendable adherence to radiation safety protocols particularly the ones with longer clinical experience. They exercised greater caution during radiographic procedures, such as refraining from holding the film in the patient's mouth and minimizing unnecessary exposure. Interestingly, practitioners with less clinical experience were more consistent in implementing certain operator protection measures, such as standing behind a lead barrier or

leaving the room during exposure. This is consistent with findings from Saudi Arabia, where undergraduate dental students demonstrated higher compliance with radiation protection guidelines compared to dental staff (15). This reflects the impact of structured radiology modules in undergraduate curricula, greater exposure to digital radiography techniques, and increased awareness of guidelines from organizations such as the ICRP and NCRP. Similar patterns have been reported in systematic reviews, suggesting that recent graduates may be more familiar with updated radiological safety recommendations due to enhanced curricular emphasis on radiation protection and the integration of digital radiography into training (19). These results also align with another cross-sectional study which have found that awareness and self-reported compliance with safety measures are often highest among dental students and new graduates, and tend to decrease with years in practice unless reinforced through continuing education (20). Overall, the findings underscore the importance of continuous professional development and regular refresher courses on radiation safety to maintain high compliance levels across all experience groups while focusing on the more experienced practitioners.

Many dentists adhered to utilizing lead aprons (85.5%) and thyroid collars (49.6%) very frequently during dental procedures. This shows their understanding that lead aprons minimizes radiation exposure to their patients, particularly to sensitive areas such as the thyroid gland and their genitals. Reasons for not utilizing lead apron or thyroid collars are perhaps due to its unavailability, compounded by inconvenience or discomfort caused by their weight (21). Also, they may obstruct the primary x-ray beam, thereby hindering dentists from obtaining the necessary image (22). Currently, the expert panel of American Dental Association in February 2024 has stated that lead aprons and thyroid collars are unnecessary, irrespective of age, health, or pregnancy (22). Some dentists preferred to use the position or distance rule over the lead apron ($p<0.05$). By adhering to this rule, dentists can effectively reduce their exposure to radiation without the need for lead aprons.

Although this study offers valuable insights, it has certain limitations such as it is a cross-sectional study and it relies on self-reported data. The sample only includes dentists practicing in private sector in Melaka, Malaysia. Generalization of the results may be inaccurate as the sample does not include dentists practicing in other states of Malaysia and those in government sectors.

CONCLUSION

Within the limitations of this study, the findings indicate that dentists in private clinics in Melaka, Malaysia, demonstrate commendable knowledge, a positive attitude, and sound practices regarding protection and safety in the use of ionizing radiation. While no statistically significant differences were observed across practitioners with varying years of clinical experience, higher knowledge scores among those with fewer years in practice reflect the influence of recent undergraduate radiology training.

These results highlight that, although baseline knowledge and awareness are strong, there is a critical need for sustained reinforcement of radiation safety principles through continuing professional development (CPD) programs, periodic hands-on workshops and updates on emerging guidelines because maintaining high standards of radiation safety is not merely a regulatory obligation but a professional responsibility that safeguards both patients and dentists. Implementing updated safety principles into everyday practice will strengthen patient protection and reinforce dentistry's commitment to safe radiographic procedures.

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