Published Online: 2025 February 26 **Research Article**

Assessment of Dentists' Knowledge and Performance Regarding Radiation Protection Principles in Dental Offices in Khorram-Abad, Iran 2023

Fatemeh Asadi Asgharani [1], Maryam Alizad [2], Maryam Mahdavi [3], Rajab Rashidi [4,*]

[1] Dental Student, Faculty of Dentistry, Lorestan University of Medical Sciences, Khorramabad, Iran
[2] Assistant Professor of Oral & Maxillofacial Radiology, Faculty of Dentistry, Lorestan University of Medical Sciences, Khorramabad, Iran
[3] Department of Occupational Health, School of Health and Nutrition, Lorestan University of Medical Sciences, Khorramabad, Iran
[4] Department of Occupational Health, Environmental Health Research Center, School of Health and Nutrition, Lorestan University of Medical Sciences, Khorramabad, Iran

[*] ***Corresponding Author:*** Department of Occupational Health, Environmental Health Research Center, School of Health and Nutrition, Lorestan University of Medical Sciences, Khorramabad, Iran. Email: rashidi.r270@gmail.com

Received: 25 October, 2024; **Revised:** 16 February, 2025; **Accepted:** 18 February, 2025

Abstract

Background: Radiography plays a pivotal role in the diagnosis and management of dental issues; however, the use of X-rays in dentistry poses potential risks to dental professionals, staff, and patients.

Objectives: This study aims to assess the knowledge and adherence of dentists to X-ray protection principles in dental practices within Khorramabad city.

Methods: This cross-sectional analytical study examined 153 dentists in Khorramabad, capturing demographic data and details such as participation in training programs, dosimetry utilization, protective measures for personnel and patients, equipment quality control, and adherence to safety protocols. Two distinct questionnaires gauged dentists' knowledge and performance. Statistical analysis was conducted using SPSS software version 25.

Results: Of the dentists surveyed, 92 were male (60.1%) and 61 were female (39.9%). Specialist dentists accounted for 29 individuals (19%), while general dentists comprised 124 (81%). A notable 92 dentists (61.1%) had engaged in continuing education courses. The average knowledge score among dentists was 19.97 (66.07%), with a performance score of 12.74 (32.09%). Significant associations were found between variables such as work experience, age, participation in educational courses, and dentists' average knowledge score ($P < 0.001$).

Conclusions: Specialist dentists demonstrated optimal knowledge levels regarding X-ray protection principles, whereas general dentists exhibited average knowledge. Despite this, overall compliance with radiation protection measures in Khorramabad's dental offices was found to be lacking. Enhanced training programs and strengthened monitoring systems are imperative to address this issue.

Keywords: Radiography, Radiation Protection, Dentistry

1. Background

Radiation, defined as the transmission of energy through matter and space, manifests in the form of particles or electromagnetic waves. Among these, X-ray diagnostic imaging falls under ionizing electromagnetic radiation (1-3). Research in the United States has revealed that dental procedures contribute a mere 0.26% to overall medical radiation exposure, with CT scans accounting for the majority. Epidemiological studies indicate that exposure exceeding 100 mSv heightens cancer risk, while controversy surrounds doses below this threshold commonly used in diagnostic radiography (4). Conversely, investigations like Hwang et al.'s 2018 study underscore a notable link between dental X-ray exposure and heightened cancer risks such as thyroid cancer and meningioma (5, 6).

Moreover, studies highlight a discernible discrepancy between occupational hazards and individual factors impacting work performance. Prolonged exposure to such risks not only jeopardizes public health but also diminishes an individual's capabilities (7). For instance, a study conducted in Seoul, South Korea in 2018 by An et al. on 207 dentists scrutinized factors like work experience, radiation usage, adherence to protective measures, and participation in radiation safety programs. The findings unveiled a significant variance in compliance with protective measures vis-à-vis dentists' work histories, with those having less than a decade of experience displaying lesser attention to radiation safety principles (8).

Similarly, a 2018 study by Almohaimede et al. in Saudi Arabia involving 329 dentists disclosed that 60% of participants acknowledged the hazards of X-rays, with a noted correlation between knowledge levels and performance. The research emphasized that dentists' knowledge and execution concerning radiation protection principles typically fall within an average range. Notably, awareness and performance levels were higher in university centers compared to government and private facilities, with only 30% of private centers demonstrating familiarity with ALARA protection principles (9).

In a parallel vein, a 2022 cross-sectional study in India by Anushya and Jayaraman involving 100 dental practitioners assessed their awareness of radiation protection principles and utilization of protective gear. Results indicated that 63% consistently used lead aprons, 85% maintained a standard distance from radiation sources, and 82% employed thyroid collars (10). Furthermore, a 2022 study in Izmir, Turkey by Yurt et al. delved into dentists' knowledge, attitudes, and adherence to radiation protection measures, revealing average scores of 8.3 out of 17 for knowledge and 8.3 out of 27 for compliance. The outcomes underscored the imperative need for enhancing dentists' understanding and implementation of protective protocols in dental imaging practices (11).

In a descriptive and analytical study conducted by Ataei et al. in 2015, the knowledge and performance of dentists regarding the effects of ionizing radiation and protection methods against X-rays were investigated in the dental offices of Babol city. The study involved 70 dentists and revealed that 70% of the participants had a favorable level of information and awareness. A significant relationship was found between the dentists' work experience and their awareness and protection against X-rays (12).

In a descriptive cross-sectional study by Ahmadian Yazdi et al. in 2018, compliance with the principles of radiation protection was assessed in 232 dental offices in Mashhad. This research recorded demographic information of dentists, participation in training courses, use of dosimeters, and protection methods for patients and personnel. The study found that thyroid shields (61.6%) and lead aprons (54.7%) were not used in most cases. Dentists who regularly participated in training courses showed significantly higher adherence to protection principles compared to other groups (13).

Attention to the life and financial consequences of occupational hazards for employees, their society, and family, as well as the human and moral aspects arising from these hazards, is of particular importance in occupational safety and health. Given the nature of dentists' work, which involves exposure to numerous harmful factors, including the risk of X-rays and dangerous infectious diseases such as AIDS and hepatitis, the use of personal protective equipment and securing the dental workplace is crucial. Increasing awareness among dentists about the consequences of ignoring occupational safety and health can play a significant role in protecting them from occupational hazards.

2. Objectives

Given the paramount significance of upholding these principles to curtail X-ray exposure risks for dentists, staff, and patients, alongside the evident disparities in awareness and practices among dental professionals, we embarked on a cross-sectional analytical study in Khorramabad dental offices in 2023 to scrutinize dentists' knowledge, performance, and adherence to X-ray protection principles.

3. Methods

This study adopts a cross-sectional analytical design. Sampling was conducted in a convenience manner, encompassing all 217 dentists in Khorramabad city in 2023 who met the study's inclusion criteria. To be eligible for participation, dentists needed to have a minimum of one year of professional experience,

possess an intraoral imaging device for questionnaire completion related to performance and satisfaction, voluntarily engage in the study, and complete the questionnaire. Dentists unwilling to cooperate or absent during the study period, along with incompletely filled questionnaires, were excluded. Data collection was anonymous, ensuring complete confidentiality and adherence to ethical guidelines.

The research employed two checklists: One assessing dentists' knowledge of X-ray protection principles and the other evaluating the implementation of these principles in dental settings. These checklists were formulated based on a comprehensive review of relevant literature, amalgamating pertinent questions aligned with the study's objectives (11). The knowledge checklist comprised 19 true/false queries, scored 1 for correct responses and 0 for incorrect ones, with scores tallied as a percentage. Similarly, the performance checklist, comprising 27 questions, followed the same scoring system of 1 for correct and 0 for incorrect responses, calculated as a percentage. To design and prepare the questionnaires, valid and relevant articles were reviewed, and a combination of questions raised in these articles was compiled for review according to the target factors (11).

The validity of the questionnaires was formally confirmed by experts in this field. The reliability of the awareness questionnaire was examined with a Cronbach's alpha of 0.715, indicating appropriate reliability, while the performance questionnaire had a Cronbach's alpha of 0.657, which is acceptable. Demographic details such as age, gender, professional experience, training course participation, dosimetry usage, protective measures for personnel and patients, exposure characteristics, equipment quality control, and adherence to safety standards were recorded. The questionnaires were completed by the researcher visiting dental offices and using observation and interview methods.

Descriptive statistics were employed to summarize the collected data, utilizing central indices for quantitative variables and frequencies/percentages for qualitative variables. The normality of data distribution was assessed using the Kolmogorov-Smirnov test. Based on the data's normal distribution, the independent *t*-test and Pearson correlation coefficient were applied. Statistical analyses were carried out using SPSS software version 25, with a significance level set at $P < 0.05$.

4. Results

A total of 153 participants were enrolled in the study according to the inclusion and exclusion criteria. Among them, 92 were male (60.1%) and 61 were female (39.9%). Other demographic characteristics of the dentists, including gender, marital status, age, and other relevant details, are presented in Table 1.

The average scores of dentists' awareness and performance regarding compliance with X-ray protection principles in dental offices are listed in Table 2. Some dentists were excluded from the performance assessment due to the absence of an X-ray imaging device in their dental offices.

The comparison of the average knowledge and performance scores of dentists regarding compliance with X-ray protection principles in dental offices across different age groups is shown in Table 3. The independent *t*-test revealed a statistically significant relationship between the average knowledge score of dentists and age groups ($P = 0.005$). However, no statistically significant difference was observed between age groups and the average performance score.

The comparison of the average knowledge and performance scores of dentists regarding compliance with radiation protection principles in dental offices by gender is shown in Table 4. The independent *t*-test indicated that the difference in average knowledge scores ($P = 0.728$) and performance scores ($P = 0.846$) between male and female dentists was not statistically significant.

Table 5 compares the average knowledge and performance scores of dentists regarding compliance with X-ray protection principles in dental offices based on work experience. The independent *t*-test revealed a statistically significant relationship between the average knowledge score of dentists and work experience ($P = 0.005$). However, no statistically significant difference was observed between work experience and the average performance score.

The comparison of the average knowledge and performance scores of dentists regarding compliance with X-ray protection principles in dental offices based on general education level or specialty is shown in Table 6. The independent *t*-test revealed a statistically

Table 1. The Frequency of Demographic Characteristics of Dentists, Including Sex, Marital Status, Age, Work Experience, Continuing Education Experience and Degree (General or Specialized)

Variables	No. (%)
Gender	
Man	92 (60.1)
Female	61 (39.9)
Total	153 (100)
Marital status	
Married	103 (67.3)
Single	50 (32.7)
Total	153 (100)
Age (y)	
40 ≥	91 (59.5)
40 <	62 (40.5)
Work experience (y)	
10 ≥	70 (45.8)
10 <	83 (54.2)
History of continuing education	
Yes	92 (60.1)
No	61 (39.9)
Total	153 (100)
Degree	
Specialist	29 (19)
General	124 (81)
Total	153 (100)

Table 2. Determining the Average Score of Knowledge and Performance of Dentists Regarding Compliance with Radiation Protection Principles in Dental Offices

Variables	Number	Minimum-Maximum	Mean ± Standard Deviation
Awareness score	153	11.11 - 100	66.1 ± 19.9
Performance score	124	7.14 - 78.6	32.1 ± 12.7

Table 3. Comparison of the Average Score of Knowledge and Performance of Dentists Regarding Compliance with Radiation Protection Principles in Dental Offices According to Age Groups

Variables and Ages	Number	Mean ± Standard Deviation	P-Value [a]
Awareness score (y)			0.005
40 ≥	91	70.8 ± 18.2	
40 <	62	61.6 ± 21.3	
Performance score (y)			0.174
40 ≥	77	33.3 ± 12.2	
40 <	47	30.1 ± 13.5	

[a] Independent *t*-test.

significant relationship between the average knowledge score of dentists and their level of education (P = 0.005). However, no statistically significant difference was observed between the educational level and the average performance score.

Table 7 presents the comparison of the average knowledge and performance scores of dentists

Table 4. Comparing the Average Score of Knowledge and Performance of Dentists Regarding Compliance with Radiation Protection Principles in Dental Offices According to Gender

Variables and Gender	Number	Mean ± Standard Deviation	P-Value [a]
Awareness score			0.728
Male	92	66.6 ± 19.8	
Female	61	67.8 ± 20.3	
Performance score			0.846
Male	73	31.9 ± 12.7	
Female	51	32.4 ± 12.9	

[a] Independent *t*-test.

Table 5. Comparison of the Average Score of Knowledge and Performance of Dentists Regarding Compliance with Radiation Protection Principles in Dental Offices According to Work Experience

Work Experience	Number	Mean ± Standard Deviation	P-Value [a]
Awareness score (y)			0.027
10 ≥	70	70.9 ± 18.7	
10 <	83	63.8 ± 20.5	
Performance score (y)			0.393
10 ≥	60	31.1 ± 11.7	
10 <	64	33 ± 13.6	

[a] Independent *t*-test.

Table 6. Comparison of the Average Score of Knowledge and Performance of Dentists Regarding the Observance of X-ray Protection Principles in Dental Offices by Section

Variables and Degrees	Number	Mean ± Standard Deviation	P Value [a]
Awareness score			< 0.001
Specialist	124	64.8 ± 20.8	
General	29	76.6 ± 12.5	
Performance score			0.820
Specialist	111	32.2 ± 12.8	
General	13	31.3 ± 12.6	

[a] Independent *t*-test.

regarding compliance with X-ray protection principles in dental offices based on their history of participation in continuing education courses. The independent *t*-test revealed a statistically significant relationship between the average knowledge and performance scores of dentists who had participated in continuing education courses compared to those who had not (P = 0.005).

Table 8 presents the frequency distribution of X-ray protection devices used by dentists in Khorramabad dental offices. As shown in the table, thyroid shields were available in 52% of the offices, but only 7% of dentists used them for all patients. Additionally, 65% of dentists did not have lead aprons in their offices.

5. Discussion

The findings revealed a statistically significant association between dentists' age, work experience, and their level of awareness. Specifically, awareness decreased with increasing age and work experience. These results align with the study by Yurt et al. (11) and can be attributed to older dentists' detachment from academic environments and limited access to updated information.

Table 7. Comparison of the Average Score of Knowledge and Performance of Dentists Regarding Compliance with the Principles of Radiation Protection in Dental Offices Based on the History of Continuous Education

Continuing Education	Number	Mean ± Standard Deviation	P-Value [a]
Awareness score			0.022
Yes	118	69.1 ± 19.8	
No	35	60.3 ± 19.4	
Performance score			0.007
Yes	99	33.6 ± 12.9	
No	25	26 ± 10.3	

[a] Independent *t*-test.

In contrast, no significant relationship was found between age, marital status, work history, and dentists' performance levels, consistent with the findings of Yurt et al. in Turkey (11). However, the study by An et al. (8) demonstrated that increased work experience significantly improved dentists' performance. Thus, it can be concluded that enhancing the awareness of younger dentists, who possess more up-to-date knowledge, does not necessarily translate into improved adherence to radiation protection principles.

Gender did not show a statistically significant association with awareness or performance levels, consistent with previous studies (11, 14). Additionally, dentists who participated in continuous education courses exhibited significantly higher average knowledge and performance scores compared to those without a history of such courses. This suggests that continuous education plays a vital role in improving dentists' awareness and performance. Notably, Javadzadeh and Alipour's study in Rasht (14) did not find a correlation between continuous education and awareness/performance, possibly due to a smaller sample size.

The study by Rashidi and Baharvand in Khorramabad highlighted the effective role of training courses in enhancing employee safety and preventing harmful occupational factors that threaten health (15).

Regarding dentists' level of awareness and performance, the study found an average awareness score of 66 out of 100 and an average performance score of 32. These results indicate that although dentists possess relatively high awareness, it does not necessarily translate into better performance. Factors contributing to low performance may include inadequate monitoring by regulatory bodies, insufficient emphasis on radiation protection principles in dental school curricula, and a lack of institutionalization.

In 67% of cases, dentists always asked their patients about pregnancy before exposure, while 31% relied on the information included in the patient file. These findings were similar to those reported by Yurt et al. in Turkey, where 62% of dentists inquired about pregnancy status (11). Awareness regarding the necessity of using a thyroid shield for all patients was recorded at 61%, which is higher than the 45% reported in the study by Yurt et al. in Turkey (11). Only 2% of dental offices reported using thyroid shields and lead aprons for both dentists and staff. In comparison, this rate was 12% in the study by Jacobs et al. in Belgium (16). The rate of thyroid shield usage was significantly higher among female dentists and staff than their male counterparts, likely due to women's heightened sensitivity to radiation exposure during pregnancy. In the study by Almohaimede et al. in Saudi Arabia, this rate was reported as 33% (9).

The results indicate that, overall, radiation protection is given little attention by dentists and staff. In the present study, nearly half of the dentists (48%) did not have a thyroid shield in their office, while 20% did not use it despite having one. This finding is similar to those reported in studies by Yurt et al. in Turkey, Ahmadian et al. in Mashhad, and Ataei et al. in Babylon (11-13). However, Javadzadeh and Alipour's study in Rasht showed a significantly higher rate of non-use, with 99% of dentists not using a thyroid shield (14).

According to the results of this study, 65% of dentists did not have a lead apron in their office, and about 40% of those who had a lead apron stated that they did not use it. The non-use of lead aprons was also reported in

Table 8. Frequency Distribution of Radiation Protection Tools Used by Dentists in Khorramabad Dental Offices (n = 124)

Protective Cases	No. (%)
Use of personal and environmental dosimeter device	
Yes	5 (4)
No	119 (96)
Radiographic technique	
Parallel	36 (29)
Bisector	88 (71)
Having a thyroid shield	
Yes	64 (52)
No	60 (48)
Use of thyroid shield	
All patients	9 (7)
Children and pregnant mothers	42 (34)
Non-use	73 (59)
Having a lead apron	
Yes	43 (35)
No	81 (65)
Use of lead apron	
All patients	2 (2)
Children and pregnant mothers	24 (19)
Non-use	98 (79)
Questions about pregnancy	
Always	83 (67)
Just relying on the patient's file	38 (31)
Not asking	3 (2)
Using a film holder	
All patients	2 (2)
Some patients	69 (56)
Non-use	53 (42)
X-ray employee	
Dentist only	21 (17)
Assistant only	32 (26)
Most of the time the dentist	10 (8)
Most of the time the assistant	61 (49)
Use of thyroid shield For dentists and office staff	
Yes	3 (2)
No	121 (98)
Use of lead apron For dentists and office staff	
Yes	3 (2)
No	121 (98)

the studies by Yurt et al. in Turkey and Ataei et al. in Babylon, with rates of 76% and 78%, respectively, similar to our study (11, 12). However, in the study by Almohaimede et al., lead apron usage was reported at approximately 75% (9). The lack of awareness, combined with insufficient supervision and carelessness, appears to contribute to the lack of access to and proper use of thyroid shields and lead aprons for patients.

Overall, the study findings indicate a moderate level of awareness among dentists but a lower level of adherence to X-ray protection principles. Although advancements in technology have led to the widespread use of digital imaging systems, continuous education and training are still needed to improve dentists' performance in implementing radiation protection measures. Regulatory bodies and dental educational institutions should emphasize radiation protection principles in their guidelines and curricula to ensure the well-being of both dental practitioners and patients.

5.1. Conclusions

In conclusion, the evaluation of dental practitioners' knowledge regarding X-ray protection principles in Khorramabad dental offices revealed optimal awareness among specialist dentists and average awareness among general dentists. However, overall compliance with radiation protection principles was generally poor. A notable observation was the widespread adoption of digital imaging systems and computerized image processing in most dental offices. Conversely, low compliance was observed in the use of protective film, rectangular collimation, and thyroid and lead aprons with adequate coverage.

To improve adherence to radiation protection principles in dental offices, several measures should be considered. These include reviewing and revising dental students' educational curricula, encouraging participation in continuing education courses, promoting the use of appropriate protective equipment, and strengthening monitoring systems. By implementing these measures, dental practitioners can enhance compliance with radiation protection protocols, ensuring improved safety for both patients and dental professionals.

5.2. Limitations

Among the limitations of this study were the lack of cooperation from dentists in completing the questionnaire and the possibility of dishonesty in their responses.

Acknowledgements

We would like to express our gratitude to the vice-chancellor of research and technology, the vice-chancellor of treatment, and the Faculty of Dentistry of Lorestan University of Medical Sciences for their assistance and cooperation in conducting this study, as well as to all those who helped in this field.

Footnotes

Authors' Contribution: All authors made equal contributions to this article.

Conflict of Interests Statement: All authors declare no conflict of interest in this study.

Data Availability: The dataset presented in the study is available on request from the corresponding author during submission or after publication.

Ethical Approval: This research was carried out with the approval of the Ethics Committee of Lorestan University of Medical Sciences (code: IR.LUMS.REC.1403.115).

Funding/Support: This study was supported by the Lorestan University of Medical Sciences.

Informed Consent: Informed consent was obtained from the participants.

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