

# Assessment Of Radiation Safety Awareness In Dental Imaging Among Dental And Nursing Professionals In Saudi Arabia: A Cross-Sectional Study

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## Abstract

**Background:** Dental imaging is indispensable in oral healthcare; however, exposure to ionizing radiation poses cumulative biological risks to patients and healthcare workers. Adherence to radiation protection principles is therefore critical. Interprofessional collaboration between dental and nursing professionals necessitates a shared and adequate level of radiation safety awareness.

**Aim:** This study aimed to assess knowledge, attitudes, and practices related to radiation safety in dental imaging among dental and nursing professionals in Saudi Arabia.

**Methods:** A descriptive cross-sectional study was conducted among 350 dental and nursing professionals working in governmental and private dental facilities in Saudi Arabia. Data were collected using a validated self-administered questionnaire. Descriptive statistics, independent t-tests, chi-square tests, and Pearson correlation were used for analysis.

**Results:** The overall mean knowledge score was  $71.3 \pm 11.9$ . Dental professionals demonstrated significantly higher knowledge scores than nursing professionals ( $75.8 \pm 10.6$  vs.  $65.9 \pm 12.1$ ,  $p < 0.001$ ). Adequate radiation safety practice was reported by 68.6% of participants. Years of experience showed a moderate positive correlation with knowledge scores ( $r = 0.41$ ,  $p < 0.001$ ).

**Conclusion:** Radiation safety awareness among dental and nursing professionals in Saudi Arabia was moderate, with significant interprofessional differences. Continuous education and structured training programs are strongly recommended to enhance radiation protection practices in dental settings.

**Keywords:** Dental Imaging, Radiation Safety, Nursing, Dentistry, Cross-Sectional Study, Saudi Arabia.

## Introduction

Dental imaging constitutes an integral component of contemporary dental practice, providing essential diagnostic information for the detection, assessment, and management of oral and maxillofacial diseases<sup>(1)</sup>. Conventional intraoral radiographs, panoramic imaging, and advanced modalities such as cone-beam computed tomography (CBCT) have significantly enhanced diagnostic

accuracy and treatment outcomes <sup>(2)</sup>. However, these benefits are accompanied by exposure to ionizing radiation, which—despite being relatively low per procedure—may result in cumulative biological effects when repeated over time <sup>(3)</sup>.

Ionizing radiation is known to induce both deterministic and stochastic effects. While deterministic effects occur above threshold doses, stochastic effects, including carcinogenesis, may arise even at low exposure levels, with risk increasing proportionally to cumulative dose <sup>(4)</sup>. Consequently, international organizations such as the International Commission on Radiological Protection (ICRP) and the World Health Organization (WHO) emphasize strict adherence to radiation protection principles, namely justification of radiographic examinations, optimization of exposure according to the ALARA (As Low as Reasonably Achievable) principle, and dose limitation for occupational exposure <sup>(5, 6)</sup>.

In dental settings, radiation safety is a shared professional responsibility <sup>(7)</sup>. Dental professionals are primarily responsible for prescribing and performing radiographic examinations, whereas nursing professionals frequently assist with patient preparation, positioning, equipment handling, and implementation of protective measures <sup>(8)</sup>. Inadequate knowledge, negative attitudes, or poor compliance with radiation safety protocols among any member of the dental healthcare team may compromise patient safety and increase occupational radiation exposure <sup>(9)</sup>.

Previous international studies have demonstrated variable levels of radiation safety awareness among dental practitioners, with gaps particularly evident in the consistent use of thyroid shields, lead aprons, and proper positioning techniques <sup>(10, 11)</sup>. Nursing professionals, despite their critical supportive role in dental radiology, have received comparatively limited attention in radiation safety research. Existing evidence suggests that nurses often rely on on-the-job training rather than formal education, which may contribute to inconsistencies in knowledge and practice <sup>(12)</sup>.

Within the Kingdom of Saudi Arabia, the healthcare system has undergone rapid expansion and modernization, accompanied by increased utilization of diagnostic imaging technologies <sup>(13, 14)</sup>. While several local studies have examined radiation protection awareness among dentists and radiology personnel, comprehensive interprofessional assessments that include both dental and nursing professionals remain scarce <sup>(15, 16)</sup>. Furthermore, the diversity of educational backgrounds and clinical experiences among healthcare professionals in Saudi Arabia underscores the need for context-specific evaluation of radiation safety awareness.

Assessing knowledge, attitudes, and practices related to radiation safety is essential not only for identifying existing gaps but also for informing targeted educational interventions and policy development. Interprofessional assessment is particularly important in dental settings, where effective radiation protection depends on coordinated teamwork. Therefore, this study provides an in-depth evaluation of radiation safety awareness in dental imaging among dental and nursing professionals in Saudi Arabia, contributing evidence to support improved radiation safety culture and enhanced patient and occupational protection.

## **Methods**

### **Study Design**

A descriptive cross-sectional study.

### **Study Setting**

Governmental and private dental clinics and hospitals across multiple regions of Saudi Arabia.

### **Study Population**

Dental professionals (dentists and dental interns) and nursing professionals working in dental radiology units.

### **Sample Size and Sampling**

A total of 350 participants were recruited using convenience sampling. The sample included 190 dental professionals and 160 nursing professionals.

#### Data Collection Tool

A structured questionnaire composed of four sections: Sociodemographic characteristics (age, gender, profession, years of experience); Knowledge of radiation safety (15 items); Attitudes toward radiation protection (10 items); Radiation safety practices (10 items). Knowledge scores were converted to a percentage scale (0–100), with higher scores indicating better knowledge.

#### Validity and Reliability

Content validity was assessed by a panel of five experts in dentistry, radiology, and nursing. Reliability analysis demonstrated good internal consistency (Cronbach's  $\alpha = 0.84$ ).

#### Ethical Considerations

Ethical approval was obtained from the institutional review board. Participation was voluntary, and informed consent was obtained from all participants.

#### Statistical Analysis

Data were analyzed using SPSS version 28. Descriptive statistics included mean, standard deviation, frequency, and percentage. Inferential statistics included independent t-tests, chi-square tests, and Pearson correlation. Statistical significance was set at  $p < 0.05$ .

#### Results

As shown in Table 1, the study included 350 participants, comprising dental professionals (54.3%) and nursing professionals (45.7%). The overall mean age of participants was  $32.6 \pm 6.8$  years, with dental professionals being slightly older than nursing professionals. Females constituted nearly two-thirds of the total sample (64.0%), with a markedly higher proportion among nursing professionals (78.8%) compared to dental professionals (51.6%). More than half of participants (59.4%) reported having five or more years of professional experience, indicating a workforce with substantial clinical exposure.

**Table 1. Sociodemographic Characteristics of the Participants (N = 350)**

Variable	Dental Professionals (n = 190)	Nursing Professionals (n = 160)	Total
Mean age (years)	$33.4 \pm 6.5$	$31.8 \pm 7.1$	$32.6 \pm 6.8$
Female (%)	98 (51.6%)	126 (78.8%)	224 (64.0%)
$\geq 5$ years' experience (%)	122 (64.2%)	86 (53.8%)	208 (59.4%)

Table 2 demonstrates a statistically significant difference in radiation safety knowledge scores between professional groups. Dental professionals achieved a higher mean knowledge score ( $75.8 \pm 10.6$ ) compared with nursing professionals ( $65.9 \pm 12.1$ ), with the difference being highly significant ( $p < 0.001$ ). This suggests greater familiarity and exposure to radiation-related concepts among dental professionals.

**Table 2. Radiation Safety Knowledge Scores by Profession**

Profession	Mean $\pm$ SD	p-value
Dental professionals	$75.8 \pm 10.6$	<0.001
Nursing professionals	$65.9 \pm 12.1$	

Table 3 summarizes reported radiation safety practices. Regular use of lead aprons was the most frequently reported practice (73.1%), followed by standing behind protective barriers (68.9%). Use of thyroid shields was less consistently reported (56.6%), and only 61.1% of participants indicated

regular equipment quality checks. These findings suggest variable adherence to recommended radiation protection measures across practice domains.

**Table 3. Radiation Safety Practices Among Participants**

Practice Item	Adequate Practice n (%)
Regular use of a lead apron	256 (73.1%)
Use of thyroid shield	198 (56.6%)
Standing behind a protective barrier	241 (68.9%)
Equipment quality check	214 (61.1%)

As shown in Table 4, years of professional experience were moderately and positively correlated with radiation safety knowledge scores ( $r = 0.41$ ,  $p < 0.001$ ). This indicates that increased clinical experience is associated with higher levels of radiation safety knowledge.

**Table 4. Correlation Between Experience and Knowledge Score**

Variable	r	p-value
Years of experience vs. knowledge score	0.41	<0.001

Table 5 shows a statistically significant difference in radiation safety knowledge by gender. Male participants had higher mean knowledge scores ( $73.9 \pm 11.4$ ) compared with female participants ( $69.8 \pm 12.2$ ), with the difference reaching statistical significance ( $p = 0.032$ ).

**Table 5. Comparison of Radiation Safety Knowledge by Gender**

Gender	Mean $\pm$ SD	p-value
Male (n = 126)	73.9 $\pm$ 11.4	0.032
Female (n = 224)	69.8 $\pm$ 12.2	

Table 6 illustrates a strong association between previous radiation safety training and knowledge level. Participants who had received training were significantly more likely to demonstrate high knowledge (66.7%) compared with those who had not received training (42.1%), with a highly significant association ( $p < 0.001$ ).

**Table 6. Association Between Previous Radiation Safety Training and Knowledge Level**

Training Received	High Knowledge n (%)	Moderate/Low Knowledge n (%)	p-value
Yes (n = 198)	132 (66.7%)	66 (33.3%)	<0.001
No (n = 152)	64 (42.1%)	88 (57.9%)	

Table 7 indicates overwhelmingly positive attitudes toward radiation safety. Most participants agreed that radiation protection is essential in dental imaging (88.0%) and that regular training improves radiation safety (91.7%). Notably, more than half of the participants (50.6%) disagreed with the statement that protective measures increase procedure time, reflecting generally favorable perceptions of radiation protection practices.

**Table 7. Attitudes Toward Radiation Safety Among Participants**

Attitude Statement	Agree n (%)	Neutral n (%)	Disagree n (%)
Radiation protection is essential in dental imaging	308 (88.0%)	28 (8.0%)	4 (4.0%)
Protective measures increase procedure time	77 (22.0%)	96 (27.4%)	77 (50.6%)
Regular training improves radiation safety	321 (91.7%)	19 (5.4%)	0 (2.9%)

Multivariate analysis (Table 8) identified profession, years of experience, previous radiation safety training, and gender as independent predictors of high radiation safety knowledge. Being a dental professional ( $\beta = 0.38$ ,  $p < 0.001$ ), having more years of experience ( $\beta = 0.29$ ,  $p < 0.001$ ), and prior

radiation safety training ( $\beta = 0.33$ ,  $p < 0.001$ ) were the strongest predictors. Gender also remained a statistically significant but weaker predictor ( $\beta = 0.12$ ,  $p = 0.041$ ).

**Table 8. Multivariate Analysis of Factors Associated with High Radiation Safety Knowledge**

Variable	B	SE	p-value
Profession (Dental vs Nursing)	0.38	0.07	<0.001
Years of experience	0.29	0.05	<0.001
Previous radiation training	0.33	0.06	<0.001
Gender	0.12	0.06	0.041

## Discussion

This study provides comprehensive evidence on radiation safety knowledge, practices, and attitudes among dental and nursing professionals, highlighting important professional, experiential, and training-related differences. The findings emphasize that while overall awareness and attitudes toward radiation protection are generally positive, significant gaps remain in knowledge and consistent application of safety practices, particularly among nursing professionals.

The present study reveals that predominance of female participants, particularly among nursing professionals, reflects the gender distribution commonly reported in healthcare workforce studies and is consistent with prior research conducted in hospital and dental settings <sup>(12)</sup>. The relatively young mean age and moderate level of professional experience observed in this study suggest a workforce that is still in a critical phase of professional development, where targeted education and training can have long-lasting effects on practice behavior.

In this study, dental professionals demonstrated significantly higher radiation safety knowledge scores compared to nursing professionals. This finding aligns with previous studies reporting superior radiation-related knowledge among dental staff due to their more frequent involvement in radiographic procedures and greater exposure to radiation-focused training during professional education <sup>(12, 16)</sup>. In contrast, nursing professionals often receive limited formal instruction on radiation safety despite their regular presence in radiological environments, which may explain the observed knowledge gap.

## Radiation Safety Knowledge and Experience

In the present study, a positive correlation between years of experience and radiation safety knowledge suggests that practical exposure and cumulative learning contribute to improved understanding of radiation protection principles. Similar associations have been reported in studies from both developed and developing healthcare systems, where experienced professionals tend to demonstrate better compliance with radiation safety guidelines <sup>(17)</sup>. However, reliance on experience alone may be insufficient, as knowledge gained informally may be inconsistent or outdated without structured reinforcement.

Moreover, Gender-based differences in knowledge scores, with males scoring slightly higher, have also been reported in earlier studies, although findings remain inconsistent across settings <sup>(12)</sup>. These differences may reflect variations in role allocation, training opportunities, or confidence in self-reported knowledge rather than true disparities in competence.

Although the majority of participants reported regular use of lead aprons and protective barriers, adherence to other essential protective measures—such as thyroid shield use and equipment quality checks—was suboptimal. This pattern mirrors findings from a previous study from the European ALARA Network (2019), indicating that compliance with radiation protection practices is often selective rather than comprehensive <sup>(5)</sup>. Partial adherence may significantly undermine the effectiveness of radiation protection strategies, particularly in high-frequency imaging environments.

Furthermore, the observed gaps in practice highlight the critical role of organizational and managerial support in reinforcing safety protocols. Studies have shown that facilities with strong safety cultures, regular audits, and clear accountability mechanisms demonstrate higher compliance with radiation protection standards <sup>(16)</sup>. This underscores the importance of translating knowledge into consistent practice through institutional enforcement and monitoring.

One of the most significant findings of this study is the strong association between previous radiation safety training and higher knowledge levels. Participants who had received formal training were substantially more likely to demonstrate high knowledge compared to those without training. This finding is consistent with systematic reviews indicating that structured education and training programs significantly enhance both knowledge and performance in healthcare settings <sup>(17)</sup>.

Training not only improves technical knowledge but also reinforces risk perception, accountability, and adherence to safety protocols. The overwhelmingly positive attitudes toward regular training observed in this study further support the need for continuous professional development as a core component of radiation safety programs.

Participants expressed strong agreement regarding the importance of radiation protection and the value of regular training, reflecting high awareness of occupational and patient safety risks. These positive attitudes are encouraging, as attitude has been identified as a key mediator between knowledge and practice <sup>(18)</sup>. The finding that most participants disagreed with the notion that protective measures increase procedure time suggests that resistance to safety practices may be more related to systemic barriers—such as availability of equipment or workflow design—rather than negative perceptions.

Multivariate analysis revealed that profession, experience, previous training, and gender independently predicted high radiation safety knowledge. Profession and training emerged as the strongest predictors, reinforcing evidence that both role-specific exposure and formal education are critical determinants of radiation safety competence <sup>(5, 17)</sup>.

These findings support a systems-based perspective, where knowledge and performance are shaped by individual characteristics as well as organizational structures. From a health management standpoint, this highlights the importance of integrating radiation safety into institutional policies, job descriptions, and performance evaluation frameworks.

### **Implications for Practice and Policy**

The results of this study have important implications for healthcare practice and policy. Mandatory, periodic radiation safety training should be implemented for all healthcare professionals working in radiological environments, regardless of profession. Additionally, health institutions should strengthen monitoring systems, ensure the availability of protective equipment, and foster a safety-oriented organizational culture consistent with the ALARA principle of the European ALARA Network (2019).

At the policy level, incorporating radiation safety competencies into professional licensing and accreditation standards may help reduce variability in knowledge and practice and improve long-term occupational safety outcomes.

### **Strengths and Limitations**

This study benefits from a robust sample size and the inclusion of multiple professional groups, enhancing the generalizability of findings. However, its cross-sectional design limits causal inference, and reliance on self-reported practices may introduce social desirability bias. Future longitudinal and interventional studies are recommended to evaluate the effectiveness of targeted training and organizational interventions.

### **Conclusion**

In conclusion, this study demonstrates that radiation safety knowledge and practices among healthcare professionals are significantly influenced by profession, experience, and training. While attitudes toward radiation protection are largely positive, gaps in knowledge and practice persist, particularly among nursing professionals. Strengthening training programs, reinforcing management

oversight, and promoting a culture of safety are essential strategies for improving radiation protection performance and safeguarding both healthcare workers and patients.

### Recommendations

1. Implement mandatory radiation safety training programs for dental and nursing staff.
  2. Incorporate radiation protection modules into nursing curricula.
  3. Conduct regular audits of radiation safety practices in dental facilities.
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