

# DENTISTS' COMPLIANCE WITH DENTAL RADIATION PROTECTION

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## Abstract

To evaluate the current knowledge, attitudes, and practices regarding radiation protection among Moroccan dentists. A cross-sectional study was conducted from April to June 2022, utilizing a questionnaire to assess the knowledge, attitudes, and practices regarding radiation protection among patients and dental staff. The study sample comprised 325 dentists practicing in the Rabat-Salé-Kénitra region. Data was analyzed using IBM SPSS software, with non-parametric statistical and linear regression tests applied. The level of significance was set at 5%. A significant number of participants demonstrated insufficient knowledge (58.4%), attitudes (87.6%), and practices (64.3%) regarding radiation protection (RP). Linear regression analyses revealed that dentist qualification ( $\beta = 0.99$ ,  $P = 0.003$ ) and RPC training ( $\beta = -1.49$ ,  $P < 0.0001$ ) were the predictors of appropriate RP knowledge. dentist qualification ( $\beta = 1.208$ ,  $P = 0.002$ ) was associated with an positive RP attitude. Working in the public sector ( $\beta = 0.77$ ,  $P = 0.002$ ) was significantly related to better RP-practice. The study's findings underscore the urgent need for comprehensive interventions, including regular training and continuing education, to improve Moroccan dentists' knowledge, attitudes, and practices regarding radiation protection, thereby ensuring the safety of both dental professionals and patients.

**Keywords:** Radiation Protection, Dentists, Dental Radiography, Dentistry, Morocco.

## 1. INTRODUCTION

X-ray imaging is widely used in medical therapy and diagnosis. In dentistry to diagnose, plan, and monitor treatments, as well as follow up pathoses [1]. While X-rays are essential for identifying dental issues, they also involve ionizing radiation, which can have harmful effects on biological tissues if misused [2-4]. Indeed, many studies, pointed out the evidence of increased risk of head and neck cancer due to exposure to low doses of dental X-ray and emphasize that accumulative exposure to low-dose radiation from dental X-rays cannot be ruled out and cannot be ignored [5,6]. Additionally, the frequency of diagnostic examinations is crucial, as the risk correlates directly/ directly proportional with the frequency of X-ray exposure [7]. An important consideration in dental radiography is its frequent use among pediatric patients, who are particularly sensitive to X-rays. Research indicates that children, especially girls, are more than twice as sensitive to ionizing radiation compared to boys. This heightened sensitivity makes them more vulnerable to long-term effects such as radiation-induced cancer, given their longer life expectancy compared to adults [1,8,9]. Dentistry is an independent healthcare practice often involving self-financing for radiological equipment, which influences dentists' decisions to prescribe radiological

examinations. They must balance the need to justify medical exposure, optimize patient radiation safety, and manage financial pressures. While ideal imaging practices should be individualized based on patient needs, many dentists' decisions are influenced by their beliefs, treatment preferences, and patient factors. Consequently, the continued use of protocol-based radiology often leads to overprescription [1,4].

Numerous guidelines have been proposed to enhance patient selection and reduce radiation exposure in dental radiography [1,10-13]. These guidelines aim to ensure that the benefits of radiography outweigh the risks, promoting patient safety and minimizing unnecessary radiation dose and associated costs. The ALARA (As Low as Reasonably Achievable) principle emphasizes keeping radiation exposure at the lowest feasible level while maintaining diagnostic efficacy. Dentists and dental healthcare providers are encouraged to adhere strictly to these evidence-based guidelines to optimize patient care and safety in radiological procedures [4,7,8]. Several studies on the knowledge, attitudes, and practices (KAP) of dentists have revealed unsatisfactory levels of knowledge regarding radiation protection [14-22]. These knowledge gaps have significantly influenced their attitudes and behaviors towards radiation protection measures. Given the importance of this issue, a thorough understanding of dentists' knowledge, attitudes, and practices regarding radiation protection is essential for enhancing patient safety and fostering a culture of security within the dental field. In Morocco, despite increased focus on radiation protection, there is a notable lack of data on dentists' KAP in this area. This study aims to address this gap by assessing the current practices, knowledge levels, attitudes, and adherence to radiation protection guidelines among Moroccan dental practitioners, thereby informing the development of more effective educational and training programs.

## 2. MATERIALS AND METHODS

### 2.1 Study Design, Ethical Consideration and data collection tool

The study was conducted in the region of Rabat-Salé-Kenitra, in Morocco. It is a cross-sectional study based on a questionnaire. The subjects of this study were all public, semi-public and private dentists practicing in the rabat-salé-kénitra region. All eligible subjects were included in the study without discrimination. The study was conducted from April 2022 to June 2022. Ethical approval was received from the Ethics Committee for Biomedical Research of the Mohammed V University of Rabat, Faculty of Dentistry, Rabat, Morocco (CERB n° 2/22). The purpose of the study was explained, and informed and written consent was obtained from all study participants. The questionnaire in the form of multiple choices questions was developed after a review of the literature relevant to KAP regarding radiation protection in dentistry (DRP-KAP) [24,18,19] and international guidelines and national regulations. The DRP-KAP questionnaire contains 41 items covering knowledge (13 items), attitudes (17 items) and practices (11 items). The I-CVIs, S-CVI/UA and S-CVI/AV and CVR values of the 41 items were  $\geq 0.86$  for each item,  $\geq 0.82$ ,  $\geq 0.97$  and  $\geq 0.71$  respectively. With regard to internal consistency reliability, the KR-20 coefficients for the knowledge and practice domains were 0.70 and 0.68, respectively, and the Cronbach alpha for the attitude domain was 0.73. Participants were invited and encouraged to partake in the study through direct contact with the researcher or via phone call, emails and SMS. Paper questionnaires were the predominate form of data collection being distributed and collected by the principal investigator in accessible areas. Electronic questionnaires

were sent via email and social media platforms (WhatsApp, Facebook) to inaccessible areas after phone contact with practice managers...

## **2.2 Animals and treatment**

We used a prevalence of 50% to obtain the largest possible sample size. Assuming that 50% of the subjects in the target population have knowledge of radiation protection in dentistry for a population size of 1250 (according to the regional council of private dental surgeons and the ministry of public health and social protection and the university hospital centre of Rabat), the study requires a sample size of 295 as calculated online with 95% confidence level and 5% error margin. In order to avoid non-respondents in our study, we considered taking 10% of the calculated sample. 10% of 295= 30, hence our sample will be 295+30= 325 dentists. A total of 325 questionnaires were distributed in rabat-salé-kenitra region. Participants were given three weeks to complete the questionnaires with reminder phone call, SMS and emails being sent by the author every 4 days to increase response rate. Inclusion criteria: Dentists of Moroccan nationality, whose worked in either the Public Dental Health Service (PDHS) or private practice (PP), generalist or specialist, practicing in the Rabat-Salé-Kénitra region, prescribing and/or performing dental radiography.

Exclusion criteria

- Foreign dentists.
- Those not occupationally active as dentists
- Dental students
- Dentists who refused to participate in the study.
- Dentists who could not be contacted
- Dentists who completed less than 40% of the questionnaire.
- Dentists who participated in the validity of the measurement instrument.

## **2.3 Data evaluation**

Knowledge-based questions were multiple-choice questions that could be answered as “yes”, “no” or “no idea”. Here, the choice of “no idea” was offered to the participant in order to avoid random marking of the answer. Thus, the participants who did not answer the question correctly (i.e. choosing either “no idea” or the other wrong answer or non-response) have no points out of that question. On the other hand, each correct answer was worth one point, so that the total number of the correct answers directly corresponded to the overall knowledge score for each participant. Questions on attitudes were multiple choice questions as well. Participants were asked to mark the answer that best-fits their individual experience on dental imaging. These questions provided the participant to choose one between the options “never”, “often”, and “sometimes”. While the correct attitude was given three points, the wrong one was given one point. Therefore, the possible score range in the section measuring attitudes was between 17 and 51. For the practice questions (11), each correct practice was given 1 point and an incorrect practice was given 0 points.

## **2.4 Operational definition**

Knowledge was determined by 13 questions, the cutoff value was 50%, means if they mark around 50% and above correct answers, it will be considered as appropriate

knowledge and who answer less than that were having inappropriate knowledge. For attitude, there were 17 questions, the dentists who marked 50% and above correct answers were thought to have positive attitude and those who did not were considered as having negative attitude. Then for practice, it was 11 questions, those who marked 50% and above correct answers were thought to have save practice and those who did not were considered as having unsafe practices

## 2.5 Statistical Analysis

The collected data were analyzed using SPSS 23.0 software. In unequal distributions, some items were turned into dichotomous items, for example, the answer options 'public', 'semi-public' and 'private' were collapsed into two categories by merging 'public' and 'semi-public'. The normality of the data was checked by Shapiro Wilk statistics. Non-parametric statistical test (Mann Whitney U test) was used to find out if differences existed according to gender, age, work experience, dentist qualification, workplace setting and radiation protection continuous training (RPC training). A linear regression analysis of the Socio-demographic and professional characteristics with knowledge, attitudes and practices scores were used to find predictors of appropriate knowledge scores, positive attitudes scores and safe practices scores. Statistical results were considered significant at  $p < 0.05$ .

## 3. RESULTS

A total of 320 responses were collected from dental practitioners out of 325 questionnaires distributed, resulting in a response rate of 92.31%. Demographic data results are summarized in Table 1.

**Table 1: Socio-demographic and professional characteristics of participating dentists**

	Characteristics	N (%) n= 320
Gender	Male	115(35.9)
	Female	205(64.1)
Age (years)	≤29	110(34.4)
	30-39	116(36.3)
	40-49	59(18.4)
	≥50	35(10.9)
Years of experience (year)	<5	108(33.8)
	5-10	96(30.0)
	11-20	69(21.6)
	>20	47(14.7)
Dentist qualification	GDP	206(64.4)
	Specialist	114(35.6)
Workplace setting	PDHS	100(32.5)
	PP	216(67.5)
RPC training	Yes	156(49.1)
	No	163(51.1)
Radiographic equipment type in practice	Intraoral x-ray units	279(87.2)
	Extoraoral x-ray units	90(28.1)
	Mobile or hand-held device	38(11.9)
	No one, refer to a radiology center	21(6.6)

PDHS. public dental health service; PP. private practice; GDP. general dental practitioner; RPC training. radiation protection continuous training.

## Outcome measure

### Knowledge

The study assessed Moroccan dentists' knowledge regarding radiation protection, focusing on their understanding of the ALARA principle and international recommendations, as well as their awareness of the annual radiation dose limit for dentists and the potential risks associated with dental X-rays. The appropriate knowledge among dentists varied significantly, ranging from 6.67% to 93.34% across these topics. Overall, the study showed that only 41.6% of the dentists had a correct understanding of radiation protection, indicating a significant gap in their knowledge.

### Attitude

The study evaluated the attitudes of dentists towards ordering X-rays, inquiring about patients' pregnancy status, and implementing radiation protection measures for both patients and staff. Results revealed that dentists demonstrated varied attitudes, with scores ranging from 11.76 to 61.76%. However, the overall adherence to radiation protection guidelines in dental radiology was notably low, as only 12.4% of dentists exhibited positive attitudes.

### Practice

The study also examined the practices of Moroccan dentists regarding radiation protection in dental radiography. The results showed that their practices related to the use of dental radiographic equipment and techniques best suited for operator and patient safety, as well as exposure reduction, were found to be highly variable, ranging from 9.1 to 81.8%, highlighting significant variability. Overall, only 35.7% of dentists demonstrated safe practices regarding radiation protection within dental radiology.

The relationship between participants' radiation protection knowledge, attitudes and practices (RP-KAP) and factors such as gender, age, experience, dentist qualification, Workplace setting and RPC training was assessed, as presented in Table 2. The analysis revealed no significant relationship between gender and radiation protection knowledge ( $p=0.25$ ), attitudes ( $p=0.45$ ) and practice ( $p=0.24$ ). However, there was a significant association between age, experience, dentist qualification, and RPC training with radiation protection knowledge ( $p=0.016$ ,  $p=0.015$ ,  $p=0.007$ , and  $p<0.0001$ , respectively). Additionally, workplace setting was significantly associated with dentists' attitudes and practices regarding radiation protection ( $p<0.0001$  and  $p=0.001$ , respectively). Dentist qualification also showed a significant association with radiation protection dentists' attitudes ( $p<0.0001$ ). Notably, specialist dentists demonstrated better knowledge and attitudes ( $p=0.007$  and  $P<0.0001$ ) compared to general dental practitioners (GDP).

The linear regression analysis result revealed that the dentist qualification and RPC training were significant predictors of radiation protection knowledge. Additionally, a significant relationship was recorded between dentist qualification and radiation protection attitude. Furthermore, workplace setting emerged as a significant predictor of radiation protection practice (Table 3).

The correlation analysis results indicated a significant association between radiation protection knowledge and both radiation protection practices ( $r=0.24$ ,  $p<0.0001$ ) and radiation protection attitudes ( $r=0.227$ ,  $p<0.0001$ ).



**Table 2: Relationship between dentists' characteristics and radiation protection knowledge, attitude, and practice**

variables		Knowledge		Attitudes		Practices	
		Med [Q1;Q2]	P-value	Med [Q1; Q2]	P-value	Med [Q1; Q2]	P-value
Gender	Male	7[5; 9]	0.25	30[28; 32]	0.45	5[4; 6]	0.24
	Female	6,5[5; 8]		30[28; 32]		5[4; 6]	
Age (years)	<40	7[5; 9]	0.016*	30[28; 32]	0.68	5[4; 6]	0.66
	≥40	6[5; 8]		30[28; 32]		5[4; 6]	
Years of experience (year)	≤10ans	7[5; 9]	0.015*	30[28; 32]	0.94	5[4; 6]	0.40
	>10 ans	6[5; 8]		30[28; 32]		5[4; 6]	
Dentist qualification	GDP	6[5; 8]	0.007*	29[28; 31]	<0.0001*	5[4; 6]	0.585
	Specialist	8[6; 9]		31[29; 33]		5[4; 6]	
Workplace setting	PDHS	7[5; 9]	0.148	29[28; 31]	<0.0001*	5[3; 6]	0.001*
	PP	7[5; 8]		31[29; 33]		5[4; 6]	
RPC training	Yes	8[6; 9]	<0.0001*	30[28; 31.25]	0.61	5[4; 6]	0.84
	No	6[5; 8]		30[28; 32]		5[4; 6]	

\*: significatif at  $p < 0.05$ ; PDHS. public dental health service; PP. private practice; GDP. general dental practitioner; RPC training. radiation protection continuous training.

**Table 3: Linear regression analysis of independent factors influence on knowledge, attitudes, and practices**

Variables	Knowledge			Attitudes			Practices		
	Beta	t	P-value	Beta	t	P-value	Beta	t	P-value
Gender	- 0.248	- 0.85	0.395	0.036	0.104	0.92	- 0.093	-0.452	0.65
Age (years)	- 0.100	-0.218	0.82	- 0.17	- 0.305	0.76	- 0.604	-1.86	0.063
Years of experience (year)	- 0.479	- 1.121	0.263	0.049	0.55	0.58	- 0.488	1.1619	0.106
Dentist qualification	0.998	3.023	0.003*	1.208	3.13	0.002*	0.213	0.93	0.353
Workplace setting	0.203	0.591	0.555	-0.713	-1.768	0.078	0.77	3.19	0.002*
RPC training	- 1.49	- 5.504	<0.0001*	0.195	0.607	0.54	-0.066	-0.34	0.728

\*: significatif at  $p < 0.05$ ; RPC training. radiation protection continuous training.

#### 4. DISCUSSION

Dental radiology plays a critical diagnostic role in dentistry, but it is also associated with increased risk of undesirable radiation exposure to both the operator and the patient. It is essential that dentists ensure adequate justification for dental radiographs and minimize radiation exposure.

To achieve this, dentists must have knowledge of radiation protection principles and adhere to proper radiation protection practices to protect patients, themselves, and others around them [15]. Considering this, the present study was conducted among dentists practising in the Rabat-Salé-Kénitra region in Morocco, to assess their knowledge, attitudes and practices regarding radiation protection.

The study revealed that the knowledge of radiation protection among dentists was not satisfactory, with only 41.6% of the dentists having a correct understanding of radiation protection. This finding aligns with previous studies, such as those conducted in Morocco<sup>23</sup> and other countries<sup>6, 14</sup>, which have shown that healthcare professionals' knowledge of radiation protection safety is often insufficient. However, our results

indicate that the range of knowledge among our participants is better than that reported in previous studies by Alavi et al. [24] (21.1%) and Singh et al. [25] (29.9%). The deficiency in regular training on radiation protection for health professionals using ionizing radiation and the lack of consistent updates for dentists regarding the harmful effects of radiation and the necessary protection protocols may contribute significantly to this knowledge gap.

Additionally, there was a significant association between age, experience, dentist qualification, and RPC training with radiation protection knowledge ( $p=0.016$ ,  $p=0.015$ ,  $p=0.007$ , and  $p<0.0001$ , respectively). The study's results revealed that participants' knowledge scores decreased with age and years of professional experience. Furthermore, the knowledge score of dental specialists was significantly higher than that of general dental practitioners (GDP). These findings are consistent with those reported by Yurt et al. [26] and Kamran et al. [27], suggesting that specialized training and continuous education are crucial for maintaining and enhancing radiation protection knowledge.

Upon evaluating RP attitude, only 12.4% of dentists exhibited positive attitudes, indicating an unfavorable disposition towards working in a radiation environment. This figure contrasts with higher percentages reported by Alavi et al. [24] (29.3%) and Singh et al. [25] (76.3%), as well as the systematic review by Behzadmehr et al.<sup>28</sup> which indicated that over 60% of health care workers had positive attitudes towards radiation protection.

This disparity highlights a notable prevalence of negative or neutral attitudes among Moroccan dentists regarding radiation protection, potentially influenced by factors such as insufficient awareness of risks, misconceptions, or even the influence of work environments. It has been demonstrated that the development of positive attitudes is essential for improving radiation protection behaviors.<sup>29</sup> Conversely, a negative or neutral attitude towards radiation protection, often linked to a lack of training and sensitization, impedes the effective implementation of knowledge in practice.<sup>24</sup>

The study also found no significant difference in attitudes towards radiation protection based on gender, age and years of professional experience ( $p=0.45$ ;  $p=0.68$  and  $p=0.94$  respectively) which aligns with the findings of Binnal et al.<sup>21</sup>

However, the attitude score of dental specialists was significantly higher than that of general dental practitioners, a finding consistent with Kamran et al. [27] but in contrast to Yurt et al.<sup>26</sup> Furthermore, the attitude score of dentists in Public Dental Health Service (PDHS) was significantly higher than that of dentists in private practice, aligning with Binnal et al. [21] and opposing Kamran et al. [27].

These findings indicate that improving attitudes towards radiation protection among Moroccan dentists requires targeted interventions, particularly focusing on enhancing awareness and training among general practitioners and those in private practice.

## Practices

The study's findings on Moroccan dentists' practices in dental radiography are concerning. Practices related to using radiographic equipment and techniques for operator and patient safety varied widely from 9.1% to 81.8%, revealing inconsistencies in radiation protection implementation. Moreover, the overall adherence to safe practice regarding radiation protection in dental radiology was found to be only 35.7%. This alarmingly low percentage underscores the need for substantial

improvements in the practical application of radiation safety principles among Moroccan dentists.

In comparison, Singh et al. [25] reported a lower correct practice rate of 19.8%, while Alavi et al. [24] found a rate of 67.6% for medium to high practice levels. Behzadmehr et al.'s systematic review<sup>28</sup> indicated a wide range of 14.3–99% for high practice levels across studies, with our study falling within this range but still below the average reported in most studies.

Additionally, workplace setting significantly influences dentists' radiation protection practices ( $p= 0.001$ ). This contrasts with the results of khani et al. [30] who reported regional differences in practice levels. Also Binnal et al. 21 found that dentists with over 11 years of experience had better radiation protection practices.

These results suggest that various contextual factors, including the workplace environment, geographic region, and professional experience, play a significant role in shaping dentists' adherence to radiation protection protocols. The differences observed between the current study and previous research highlight the need for a thorough understanding of both organizational and individual determinants of radiation safety practices in the dental field and other medical field [31-33]

The linear regression analysis in this study revealed that dentist qualification and RPC training were significant predictors of radiation protection knowledge. Additionally, dentist qualification was significantly associated with radiation protection attitude, while workplace setting emerged as a significant predictor of radiation protection practice.

The linear regression analysis result revealed that the dentist qualification and RPC training were significant predictors of radiation protection knowledge, while dentist qualification was also significantly associated with radiation protection attitude. Additionally, workplace setting emerged as a significant predictor of radiation protection practice.

These results are consistent with previous studies, such as Hassan et al. [34], which found that age, gender, and specialty of participants are significant predictors of knowledge, while age and working load of participants were significant predictors of practice. Similarly, Alavi et al. [24] reported that area of study, marital status, and levels of education are significant predictors of knowledge, while gender and experience period with radiation significantly predict radiation protection practice, and in-service training significantly predicts radiation protection attitude.

### **Limitations:**

This study has several limitations that should be considered when interpreting the results. Firstly, the majority of participants were general dentists, mostly working in private practice, which may not be representative of all dental professionals. Additionally, the distribution of participants was not equal between male and female participants, which could impact the generalizability of the findings. Furthermore, the study may have been affected by memory bias and idealization problems due to the nature of self-reported data. Moreover, some responses may not be accurate as respondents may have been reluctant to reveal any unethical behaviors implemented in their practice setting. Finally, the role of dental assistants in taking radiographs was not precisely defined, which could impact the accuracy of the data collected.



## 5. CONCLUSION

In conclusion, the association of ASD and nutrient deficiency notably vitamin A could exacerbate the ASD pathogenesis. The evidence indicates that oxidative stress is an integral part of the pathophysiology of ASD and is linked to the severity of the characteristic symptoms exhibited by children having ASD. Taken into account the potential role of vitamin A and oxidative status of children with ASD, we suggest that these two parameters can be used as biomarkers to elucidate the mechanism by which VAD and ROS induce ASD during neurodevelopment. Moreover, many further research studies are needed to understand how to improve the child's symptoms and alleviating their suffering.

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